# NATURE

No. 4180 SATURDAY, DECEMBER 10, 1949 Vol. 164


## CONTENTS


| | Page |
|---|---|
| National Park Areas in Great Britain | 973 |
| Sir Frederick Gowland Hopkins. By Dr. A. B. L. Beznák | 976 |
| Quantum Theory of Fields. By Prof. L. Infeld | 977 |
| The Ways of Fishes. By G. A. Steven | 977 |
| Psychology in the Services | 978 |
| Liverpool School of Tropical Medicine: Fiftieth Anniversary | 980 |
| Human Problems of Work Design. By Dr. N. H. Mackworth | 982 |
| Biochemistry and Physiology of the Cell. By Prof. J. N. Davidson | 984 |
| Folic Acid, Vitamin $B_{12}$ and Anæmia. By Dr. E. Lester Smith | 986 |
| Obituaries: | |
| Dr. A. P. Laurie. By Dr. P. D. Ritchie | 987 |
| Prof. Alexander Meek. By Prof. A. D. Hobson | 988 |
| News and Views | 989 |
| Galactopoietic Activity of Purified Anterior Pituitary Growth Hormone. By P. M. Cotes, J. A. Crichton, Dr. S. J. Folley and Prof. F. G. Young, F.R.S. | 992 |
| Radiation Effects Due to Phosphorus-32 in Fertilizer Experiments. By R. Scott Russell, S. N. Adams and R. P. Martin | 993 |
| Meeting of Bavarian Physicists. By Dr. Gabriele Rabel | 995 |
| Oil-fields of North-west Germany. By Dr. W. J. Arkell | 996 |
| The Electrical Engineer and the Community. By J. G. | 996 |
| The John Innes Horticultural Institution: Annual Report | 997 |
| International Conference on Science Abstracting | 998 |
| Letters to the Editors: | |
| The Scintillation of Stars.—Prof. H. Hartridge, F.R.S., and Dr. R. Weale | 999 |
| Inelastic Scattering of Deuterons.—Dr. J. R. Holt and C. T. Young | 1000 |
| Use of *Bremsstrahlung* in Making Rapid Assays of Millicurie Amounts of Phosphorus-32.—Tikvah Alper and Lorene du Preez | 1001 |
| A Short-lived Metastable State in Titanium-46.—B. D. Nag, Sunil Sen and Santimay Chatterjee | 1001 |
| Crystal Structure of Ovalene.—D. M. Donaldson and Prof. J. Monteath Robertson, F.R.S. | 1002 |
| Electrification of Liquid Drops.—E. W. B. Gill and G. F. Alfrey | 1003 |
| Atomic Binding Energies.—Dr. W. E. Duncanson and Prof. C. A. Coulson | 1003 |
| A Measurement of the Velocity of Light.—Dr. R. A. Houstoun | 1004 |
| Unsymmetrical Hysteresis Loops in a Nickel–Iron Alloy.—J. L. Rothery and Dr. An Wang | 1004 |
| Geodetic Measurements by Radar.—D. J. Halliday | 1005 |
| Use of Aspherical Surfaces in the Design of Magnifiers for Binocular Vision.—J. H. Jeffree | 1006 |
| Creation of Matter in the Universe.—T. Gold | 1006 |
| Effect of Muscular Exercise and of Urethane Administration on the Incorporation of Carbon-14 into Animal Tissue.—Prof. G. Hevesy, For.Mem.R.S. | 1007 |
| Hæmolysis by Newcastle Disease Virus.—Prof. F. M. Burnet, F.R.S. | 1008 |
| Enzymatic Degradation of Desoxyribose Nucleic Acid by Crystalline Desoxyribonuclease.—Dr. G. Jungner, I. Jungner and L.-G. Allgén | 1009 |
| 'Vegetative Hybridization'.—L. Sachs | 1009 |
| Are Aquatic Phycomycetes Present in the Air?—Wan-nien Siang | 1010 |
| Enhancement by 'Visible' Light of Recovery from Ultra-Violet Irradiation in Animal Cells.—Dr. Harold F. Blum, Gordon M. Loos, Judith P. Price and J. Courtland Robinson | 1011 |
| Micro-Anatomy of the Hepatic Circulation.—Dr. W. H. Horner Andrews, Prof. B. G. Maegraith and C. E. M. Wenyon | 1011 |
| Water Content of Saliva Dried at Various Humidities.—O. M. Lidwell | 1012 |
| Extraction of a Specific Antigen from the Virus of Lymphogranuloma venereum.—C. F. Barwell | 1013 |
| Transpiration into a Saturated Atmosphere.—Dr. K. Wilson; Prof. D. Thoday, F.R.S. | 1013 |
| Veratrole and π-Complexes.—Dr. G. Baddeley and Neville H. P. Smith | 1014 |
| A New Intermetallic Phase in Alloy Steels.—Dr. K. W. Andrews | 1015 |
| Heating Metal Specimens in Corrosion Tests.—R. F. Thirsk, G. H. Botham and G. A. Dummett | 1015 |



*Editorial and Publishing Offices of "NATURE"*
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
*Advertisements only should be addressed to*
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone Number: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad


All rights reserved. Registered as a Newspaper at the General Post Office


## NATIONAL PARK AREAS IN GREAT BRITAIN

ALTHOUGH the National Parks and Access to the Countryside Bill was unopposed on its second reading in the House of Lords on October 19, as in the House of Commons, its reception was even chillier. For the objects of the Bill there was cordial and almost universal approval; but there was profound scepticism on all sides as to the adequacy of the Bill to achieve its objectives. By and large, the departures from the recommendations of the Hobhouse Report were regarded as likely to render the Act ineffective so far as the establishment of the system of national parks and Nature reserves and the preservation of natural beauty and amenity are concerned.

Cogent reasons were advanced by one speaker after another in the debate for a general lack of confidence in the willingness or ability of the present Minister of Town and Country Planning to make the Bill effective; but such misgivings were insignificant compared with the profound distrust of government departments manifest throughout the debate. Lord Samuel was prompt to seize on the ominous remark of the Paymaster-General, Lord Macdonald, in introducing the Bill, that the Government was not prepared to guarantee that the activities of the British Electricity Authority or other undertakings should not be allowed to despoil the areas which may come to be designated as national parks. Lord Samuel, like every other speaker, recognized that the national parks areas cannot be sterilized, and that one major problem is to reconcile the divers local interests in those areas with the national interests. He sought an assurance that every application from such undertakings would be most carefully scrutinized, and, where an alternative was possible, the Minister would not hesitate in a proper case to refuse sanction.

No such assurance was given, nor was there any indication that the Government has accepted the fundamental thesis in the whole conception of national parks in such a country as Britain: that there are some areas in which the supreme national interest is amenity. The failure to accept that thesis and adopt the appropriate safeguards accentuates the danger of the threats which come from government departments. As Lord De La Warr said bluntly, the problem of safeguarding amenity in most cases has become that of controlling the activities of government departments. The troubles that afflict the countryside of Britain are due mainly to Government departments or statutory boards set up by Government departments. Hitherto, as Lord Llewellin observed, it has not been the formal duty of anyone to look after the preservation and enhancement of natural beauty in Britain; what we now need is authority to protect effectively the national parks from government departments and large nationalized undertakings, with their powers of compulsory purchase and freedom from challenge in the courts. Lord Hylton reiterated this point, and added that the Bill does nothing to solve the problem because the National Parks Commission and the local planning

authorities alike have no power, and hitherto the Minister of Town and Country Planning has not defended the interests of amenity effectively.

Lord Harlech was more specific in his assertion that the real threat to-day to the Snowdonia National Park comes from the centralized bureaucratic government institutions, and he instanced the British Electricity Authority, the War Office with its artillery range in the middle of the Snowdonia National Park, and the Forestry Commission. He made a powerful plea for local administration, but urged that the National Parks Commission must have power against government departments and be able to make representations through a Minister to the Cabinet as a whole so as effectively to prevent undesirable activities of State departments. To Lord Harlech it was one aspect of a growing threat to the liberties of the people of Britain, to their amenities and to their whole traditional way of life, and in this view he had the warm support of Lord Pethick-Lawrence.

Lord Pethick-Lawrence was clearly dubious whether the Bill gave the Minister of Town and Country Planning any powers at all to preserve the countryside and to make it more accessible to the general public; but his remarks were directed chiefly towards scheduling of footpaths and the recovery of rights-of-way temporarily abandoned for public needs. He regarded that as of supreme importance; for unless steps are taken now, we may lose for ever the rights-of-way which were the joy, the glory and the freedom of the countryside. Lord Rochdale, supporting Lord Harlech's observations, directed attention to the need for seeing that no loopholes are left of which any government department or nationalized board could take advantage and start development without early and continuing consultation with the national parks planning boards or the National Parks Commission.

For all the strong feeling evinced in the debate on these points, there was abundant evidence that even those who are most anxious about the activities of government departments recognize that many of the demands for land are legitimate national interests. Land is required for hydro-electric development, for training areas, for catchment areas and mineral workings as well as other purposes, and at some level those demands have to be assessed and adjusted with other national interests such as amenity. That, however, is manifestly not being done, and Lord Macdonald, in winding up the debate, ignored this issue entirely. Like every other Government spokesman on this question, he declined to face the real issue that neither men nor departments should be judges in their own cause, and that it is for the independent body or Minister to decide whether the particular national interest involved is so urgent and vital that we must pay the price of what is involved in loss of beauty, scenic heritage or amenity.

Several points stressed in the debate have been emphasized in subsequent events and publications. Lord Esher suggested that one reason for the cool reception given to the Bill is to be found in the treatment the National Trust has received under it. Pointing out that the National Trust has consistently sought to create national parks on the lines approved by the Ministry, and that the Trust has always encouraged the greatest possible degree of access to the 150,000 acres which it now owns in England and Wales, Lord Esher expressed regret that the Government does not propose to grant absolute exemption to National Trust land. It is clear, he said, that supporters of the national parks idea prefer a strong National Parks Commission to a Ministry of Town and Country Planning with greater powers. This is due to mutual distrust arising between the Ministry and the natural supporters of the Bill, and he hoped that the Government would, on the Committee stage, move an amendment as a gesture of conciliation which would remove such distrust before it is too late. That wish is reflected in the fifty-fourth annual report of the National Trust, since published, which records the Council's regret that the Bill is not based more closely on the proposals of the Hobhouse Report, and that the inalienable land of the Trust is not given complete exemption from the powers of compulsory acquisition provided by the Bill. The Council's concern that the 'special procedure' under which the Trust can insist upon any proposal to acquire its inalienable land being brought before Parliament affords insufficient protection is well founded while the Government overburdens Parliament so heavily, and is so manifestly unwilling to allow Parliament to take its proper role as the 'grand jury' of the nation. At the annual meeting of the National Trust on November 11, the speeches of Lord Crawford and Sir Norman Birkett expressed the same disappointment regarding the National Parks Bill.

Doubts that arise on this issue as to whether the present Bill will give the nation even any local-authority parks worth having are scarcely modified by what is already happening in consequence of the clause which enables the Minister to dispense with joint boards in special circumstances. In the debate on the second reading in the House of Commons, Mr. Silkin stated that it would be contrary to the purpose of a national park for different authorities to administer different parts of it in different ways. Only in exceptional cases would he consider an advisory committee at all. If the bulk of the area lay in one county and only small fragments in others, that might be a sensible arrangement. In the committee stage, however, Mr. Silkin suggested that where a number of authorities have been working well together, the best results might be secured by permitting these looser arrangements to continue rather than to constitute the joint board required by the Bill.

The chairman of the Joint Committee for the Peak District National Park has now reported that the County Councils of Derbyshire, Cheshire and Staffordshire have, acting on this hint, agreed to oppose the formation of a joint board for planning the proposed Peak District National Park. They suggest instead that each county council with territory in the Peak District National Park should remain in control of the planning of its own part, and that a joint advisory committee should be set up to co-ordinate the administration of the area as a whole. As a result the Peak District National Park, instead of being

planned by one authority with its own planning officer and staff, would be planned by five separate planning committees each with its own planning officer and staff, and each with headquarters several miles outside the national park itself.

It is not certain, of course, that the Minister would agree to this proposal; but it is to be hoped that the full significance of this clause will be made clear or its provisions tightened sufficiently to prevent evasions of this kind. There can be no substitute for a single planning authority if it is intended to plan and manage the national parks as they were conceived by the Dower and Hobhouse Committees. The maximum concession in this respect would be for the single local-authority planning committee to be appropriately constituted and made responsible even for those small areas in the national park which lie outside its normal county responsibilities.

The question of this escape clause and of the use of joint planning boards is raised in the Report and News Letter of the Friends of the Lake District issued last September. The publication of this News Letter was delayed until an account could be given of the National Parks Bill in the form in which it left the House of Commons. The News Letter points out that only one joint committee has been voluntarily set up by the authorities to cover the expected area of a future national park. That was in the Lake District. This committee met four times in its first year—and did very little. It did not meet in its second year and lapsed after July 1, 1948.

Besides its reasoned condemnation of the Minister's jettisoning of the principle of a single, unified and autonomous planning board for each national park, whether the area lies in one or in a number of counties, the News Letter also criticizes the nomination of a third of the national members on the Park Planning Board by the Minister and not by the Commission itself, although the Minister is to consult the Commission. Again, the News Letter challenges the limitation of the National Parks Commission itself to purely advisory and supervisory powers, and criticizes shrewdly the attempts to weaken its authority and status where there is any possibility of its views conflicting with those of government departments, even in such matters as its annual report. In the committee stage in the House of Commons an amendment was carried against the Minister authorizing the Commission to include in its annual report to Parliament particulars of any dealings held during the year between the Commission and any government department, local authority and statutory undertaker, with a summary of any evidence which may have been adduced by the Commission in the course of any proceedings. On the report stage, however, the Minister arranged for this amendment to be substantially modified, and the annual report is now to cover "all questions with which the Commission has been concerned . . . which appear to the Commission to be of general public interest". The Commission may, indeed, take a wider and proper view of the public interest; but the whittling of its powers will not make it easier to obtain men and women of the strong character and personality required to serve on the Commission. If the conflicts between the Commission and other government departments are to be satisfactorily resolved, they must come back to Cabinet level and to the House of Commons, and the nation in the last resort. They cannot be allowed to rest with the Minister of Town and Country Planning. The News Letter hammers home this point, as was done in the House of Lords. The real threats to national parks and to amenity in Great Britain come from the government departments and the statutory bodies, and the vital question is what form the authority must take to restrain them effectively and prevent them any longer from being judges in their own causes.

One most effective weapon is publicity, and the News Letter of the Friends of the Lake District does well to direct attention to the danger that the National Parks Commission may be denied it to a sinister extent. On the other hand, the Commission has no stated right of access, especially at an early stage, to information about the activities of the British Electricity Authority or like independent corporations, and the course of the hydro-electric schemes for North Wales on which Lord Harlech spoke so eloquently in the House of Lords debate illustrates the vital importance of early information in such matters. As the News Letter rightly points out, the National Parks Commission will have, under the present Bill, no guaranteed right of a direct approach to any such corporation as the British Electricity Authority, and the strong opposition to the hydro-electric proposals for North Wales which has been organised by the Council for the Preservation of Rural Wales appears to depend on the unofficial or accidental divulging of information. In the reasoned criticism of the proposals which that Council has already issued, the Council has strengthened its general argument by the concessions it has made on specific points where the effects on the scenery and rural solitude of North Wales are likely to be less disastrous.

The British Electricity Authority has also been concerned in another matter affecting amenity, and that is the question of pylons or underground cables. The News Letter of the Friends of the Lake District puts this matter in its proper perspective when it points out that what is required is a relatively small addition to the general cost of electricity to provide underground cables in certain places of special landscape value, so that what is of national importance may be preserved from disfigurement by a national policy. Such a common-sense policy was one of the purposes of the Electricity Act of 1947; yet it is ignored by officials of the Lakeland sub-area, while fresh threats are being offered to the Malvern Hills.

The Friends of the Lake District and the Council for the Preservation of Rural England are endeavouring to get the matter put on its true basis; but it should be remembered that here again it was the intention of the Hobhouse Committee that the National Parks Commission should be responsible for any such negotiations required to safeguard the landscape. The fact that in the absence of a National

Parks Commission the Minister of Town and Country Planning, to whom the Commission under the present Bill would be only advisory, has been so indifferent or ineffective in all these matters, is one fundamental reason for questioning whether any system of national parks will ever be developed in Great Britain under the present Bill. At least as much will depend on the vigilance of the existing amenity societies if the Commission is to have any chance of being effective, and the widest possible publicity must be secured for its reports and activities. Only increasing vigilance and the unrelenting and determined pressure of an informed public opinion can hold out any hope that the declared purposes of the Bill may be even partially achieved while the Government steadfastly declines to take the essential steps required to terminate these disputes and perpetual threats to the ideas of both national parks and Nature reserves. There can be no substitute for some authority of the character of an interdepartmental committee at Cabinet level, strong enough and competent not only to balance conflicting claims on a national basis, but also to check piecemeal procedure, with its waste of time and needless friction. Nor can a national park or Nature reserve take shape unless the planning and administration of each park or reserve is entrusted to a single qualified body able to take a national and not a sectional or local view, and which will have regard to long-term interests rather than immediate exigencies or difficulties.

## SIR FREDERICK GOWLAND HOPKINS

### Hopkins and Biochemistry, 1861–1947

Papers concerning Sir Frederick Gowland Hopkins, O.M., P.R.S., with a Selection of his Addresses and a Bibliography of his Publications. Edited by Dr. Joseph Needham and Dr. Ernest Baldwin; with a Foreword by Prof. A. C. Chibnall, and Contributions by Dr. Malcolm Dixon, Dr. Leslie J. Harris and Dr. Marjory Stephenson. A Commemoration Volume prepared on the occasion of the First International Congress of Biochemistry, Cambridge, 1949. Pp. ix+361. (Cambridge: W. Heffer and Sons, Ltd., 1949.) 18*s*. net.

THE *œuvre* and personality of Sir Frederick Gowland Hopkins have quite recently been appraised by the most outstanding representatives of his own and allied sciences. These articles appear in easily accessible periodicals. What, then, was the need the editors of this volume sought to satisfy? The answer may perhaps be found in the article by Dr. and Mrs. Needham: "Hopkins was a personality which drew from his colleagues not only intellectual admiration but deep affection and even veneration. . . . One never came across anybody at all like him, and now one is sure one never will." This book is a revolt against this final loss. So far as such an impossible aim can be attained, it brings Hopkins to life again. "The matter of deep regret that he left behind no single book embodying his conception of the subject he brought to life" (Dr. Marjory Stephenson) is thus remedied. Indeed, through Dr. L. J. Harris's collection of addresses by Hopkins and the presentation of a classical catena of excerpts from his scientific papers, the book conveys to the reader not only the synopsis of Hopkins's conceptions, but also the entire process of their development, together with the development of the historical setting in which they occurred. It is by letting Hopkins himself speak and act—and not by speaking of him—by presenting his brain-wave mechanics that the book brings him to life.

Functional biochemistry is tackling now a problem not less difficult than was the problem of protoplasm in Hopkins's time. The conception of chemical organisation by enzyme specificity is now universally appreciated. Besides this, the particulate architecture of the cell appears to gain in importance. These particles, composed of different enzymes and substrate systems, are the organs of the cell. The problem now is their integration. Those engaged in research on such problems will find many stimulating ideas and much sound advice in Hopkins's addresses. They will find these just as fresh and new as did those who were tackling the concept of protoplasm.

The reader whose interest lies more in the mode of the growth of scientific truth will read with much satisfaction—as Dr. L. J. Harris vividly demonstrates—biochemical truth being made to grow and to differentiate by Hopkins's creative genius. Such a reader will be inclined to endorse the view of Max Planck, who held that the universe is an infinite pattern of interrelated causal relationships. From the starting-point of a new discovery, the next step may be taken in any of an infinite number of directions. Which of these will actually be taken depends on the personal choice of the investigator. The system of scientific truth is thus more a fabric of the human mind than an ever-expanding chart of the unknown. We do indeed see that the discovery of, for example, glutathione, with its functions as a molecular organellum in cell respiration, owes its place in systematic knowledge to the fact that Hopkins chose to pick up the observations of de Rey-Pailhade. But when one sees facts forcing investigations away from the *faux pas* of glutathione being a dipeptide into the right direction of its being a tripeptide, and the consequences of its purification on the concept of its function in cell respiration, one realizes that though the finite pattern of scientific knowledge is a creation of the human mind, as a fraction of an infinite pattern of relationships, nevertheless within the finite system of scientific truth the picture can be brought very near to the objective truth.

Hopkins, alive in this book, gives his view on this very problem as well. Describing respectively the effect of the personalities of Liebig and Pasteur on the development of biochemistry, he clearly endorses Planck's view. Needless to say, in Hopkins's view the fabric of scientific truth is not a structure of abstract imagery. It is a partial reconstruction model of cause and consequence relationships actually existing in Nature, as revealed by experimentation.

After the biochemist and the philosopher of science, the sociologist also may find material for thought in some of Hopkins's addresses. "Next to biochemistry his great interest lay in socialism" (Sir Charles Sherrington). Hopkins's socialism was not of the fanatical doctrinaire kind. It sprang from a profound sympathy and understanding for the man bearing the burden of life. The means of lightening this load he saw in practical and feasible measures carried out by men motivated by moral principles, and not as

products of the mechanical working of the laws of political economy. Nothing was more alien to the nature of Hopkins than a fanatical desire to realize in human society, regardless of its cost in human suffering, a dogmatic scheme.

Let us now turn to his autobiography. If the fabric of truth is a construction of the human intellect, then a man of science is more of an artist than a kind of super-technician. He is consequently to be weighed by the same values as artists. Of these Rodin said: "The love of nature and sincerity are the two great passions of an artist". Hopkins's autobiography testifies to the presence of both of these passions. His sincerity was that of an extrovert, in the sense of C. G. Jung's typology. There is nothing in it of the self-seeking exhibitionism of the introvert with a morbidly shrunken ego. He views himself from without, and describes, not confesses in a theatrical manner, his life, not in order to get sympathy or admiration from his fellow-men, but to give them facts of his life, the knowledge of which may be useful in their struggle for a better, a more human life. He ends his short and brilliant autobiography with the words "Fortunatus sum", and with the attitude of a true extrovert he thinks of fortune as something outside him, apparently not realizing that "character is fate". To be able to say "Fortunatus sum" is the extrovert way of expressing the thought: I have a perfect character. The psychologist may find material in his study of the question how far a man of science is born or is made. Whatever the proportion of inherited or environmental determinants in the formation of a personality may be, Hopkins realized that most of them are outside our personal control. He described his own qualities (some of which he regarded as shortcomings, others as excellences), with a modesty verging on humility, as things given to him and not as achievements attained by him. He regarded himself as an unschooled amateur, having not realized that this feeling is the consequence of "a genius being him, who knows more than he learnt".

A. B. L. Beznák

## QUANTUM THEORY OF FIELDS

### Quantum Theory of Fields

By Prof. Gregor Wentzel. Translated from the German by Charlotte Houtermans and J. M. Jauch. Pp. ix+224. (New York and London: Interscience Publishers, Inc., 1949.) 36*s*.

TO say that this is the best book on the quantum theory of fields is no praise, since to my knowledge it is the only book on this subject. But it is a very good and most useful book. The original was written in German and appeared in 1942. This is a translation with some minor changes. A few remarks have been added, concerning meson theory and nuclear forces, also footnotes referring to modern work in this field, and finally an appendix on the symmetrization of the energy momentum tensor according to Belinfante.

Thus Wentzel's book presents the state of knowledge of this subject as it was some six years ago. But in the last two years, important progress has been made connected both with the Lorentz-invariance of the quantization scheme and with the treatment of infinities. This spectacular development is due to the work of Weiss, Tomanaga, Dirac, Heitler, Schwinger, Dyson, Feynman, and many others. Obviously this recent progress is not included in the book. Yet, this is not a drawback. We seem to be too near to this new development to evaluate properly its role in theoretical physics. Great simplification may occur, and perhaps even entirely new ideas may be introduced in the future.

Wentzel's book deals skilfully with the basic methods and excellently achieves the author's purpose: "to provide the reader with such basic information as will enable him to follow independently the original literature now appearing in the periodicals". Indeed, it is an excellent introduction to more modern work. What is especially attractive about the book is the presentation of a uniform and powerful method which can be applied successfully so long as interaction problems do not appear. Thus, one basic theme is introduced and systematically broadened; starting with the scalar meson field, the book then proceeds to the vector meson field, and the same scheme is further generalized and adapted to the electromagnetic field and the electron field. The last chapter is a fascinating one on particles with higher spin and on the connexion between spin and statistic. Because of its logical structure, the book seems to become easier as one goes further ahead.

Of course, there are some faults, too. It could scarcely be otherwise, since this is a pioneer work,—the first attempt at synthesis in book form. The first chapter, and especially the treatment of Lorentz invariance, seems to me the weakest part of this book. But this is not important compared to its many virtues; it is an excellent guide for graduate students and teachers alike in this new and difficult subject. Let us hope that the author will produce a new edition which will modernize the book and appear when the time is ripe for it. This is not yet.

L. Infeld

## THE WAYS OF FISHES

### The Life Story of the Fish

His Morals and Manners. By Brian Curtis. Pp. xii+284+6 plates. (New York: Harcourt, Brace and Co., 1949.) 3.75 dollars.

### The Ways of Fishes

By Dr. Leonard P. Schultz, with Edith M. Stern. Pp. xii+264. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1948.) 30*s*. net.

### Sport Fishing in Canada

By Francis C. Whitehouse. Pp. xvi+188 (49 plates). (Vancouver, B.C.: The Author, 1109 Burnaby Street, 1948.) 3 dollars.

FISHERMEN, both amateur and professional, in salt water and in fresh, have long been puzzled by many things concerning the fish that they catch. "Do fish sleep? What colours can they distinguish? Do they suffer pain? How do they find the way?" are but a few of the questions to which they are always seeking and seldom finding reliable answers. Nevertheless, by observation and simple experiment based mainly on trial and error, such amateur naturalists have made many interesting and valuable contributions to our knowledge of fish life. Perhaps their most important discoveries have been where to find the fish and how to catch them—both prerequisites to finding out most other things about them.

Men of science, too, have long been studying fish both in the field and in the laboratory, and by

application of the more precise methods of research have added greatly to our knowledge of fish life. Much of this information is buried in scientific publications not available to the layman, and often couched in technical language that he would not understand anyway. In "The Life Story of the Fish", first published ten years ago, its author endeavoured to provide a readable digest of all available information about fish, both scientific and otherwise, and in his own words, "to set forth all that was known about fish that might be of interest to the angler, the aquarist and to the normal human being of enquiring mind". The present edition has been revised and largely rewritten in order to bring it up to date. It is a veritable mine of useful information about the structure, habits and life-histories of fishes, including salmon, trout and other game fish, and should prove of interest and value to a large public. It is a pity that here and there the popularization is overdone by the inclusion of such statements as "the striped bass is only half an inch long when he succumbs to modesty"—that is, when scales first begin to develop. But the title of the book will warn the reader to expect such lapses, for it is hard to understand what possible meaning can be attached to "morals and manners" as applied to fishes.

"The Ways of Fishes" is also a popular book covering very much the same general ground as the above, but rather less successfully. For many amateurs perhaps the most interesting chapters are those dealing with aquaria and aquarium keeping.

The third book, "Sport Fishing in Canada", is intended to serve as a "Compleat Angler" for northern North America from Newfoundland to the Yukon; and since the Canadian game fishes are mainly the same as those of the northern United States, it applies also to fishing south of the border. All the important fishes are included—their distribution, fishing methods and fighting qualities being discussed at length. There are seventy illustrations, a number of which are of poor quality and fail to do justice to the book.

G. A. STEVEN

---

## PSYCHOLOGY IN THE SERVICES

### Personnel Selection in the British Forces

By Dr. P. E. Vernon and Dr. J. B. Parry. Pp. 324. (London: University of London Press, Ltd., 1949.) 20*s*. net.

DURING the Second World War psychological methods of personnel selection were developed in all three Fighting Services in Great Britain on an unprecedented scale. In the course of the first year, a few tentative investigations into the possibility of classifying recruits by means of tests and similar devices were carried out by psychologists, usually on their own initiative; but these experiments were not very extensive and often not very welcome. Shortly after the Dunkirk evacuation, however, a Psychological Advisory Committee, consisting of Sir Cyril Burt, Prof. J. Drever and Dr. C. S. Myers, was appointed by the new Adjutant-General, Sir Ronald Adam; and on their recommendation, a Directorate for Selection of Personnel was established. A scheme of testing and allocation was worked out, first for new recruits and afterwards for officers. Similar arrangements were introduced in the Navy and in the Air Force. Dr. P. E. Vernon, almost from the very start, was officially connected with the researches set on foot both at the Admiralty and at the War Office; and at a later stage Dr. J. B. Parry succeeded Prof. E. A. Bott as head of Training Research (as it was called) at the Air Ministry.

The book which they have now jointly written gives a brief history of the way in which the administrative procedures were developed in each of the three Services, describes in detail the tests and other methods that were eventually adopted, and summarizes the more important results. Their aim is not so much to explain how military efficiency may be improved by the use of psychological devices, or to discuss their researches from a technical point of view; they have addressed themselves rather to the industrialist and the educationist, and their object is chiefly to show how the methods employed with such success during the War may now be applied with equal benefit to the problems of peace.

They begin with an instructive chapter on the rise of vocational psychology in Great Britain. As they point out, the scientific foundation was laid by Galton's work on individual differences and the ingenious experimental and statistical procedures that he elaborated. The application of such methods to practical problems began with the appointment of a psychologist to the London County Council in 1913. Later it was found convenient to extend the psychologist's work to cover the supervision of the new Department of Vocational Guidance in the National Institute of Industrial Psychology. Vocational guidance was thus treated as a continuation of educational guidance; and the principles, the methods, and even the terminology gradually evolved for the testing and classification of children at school have thus been largely taken over for the work of personnel selection among adults. In the Forces the psychological investigation arising out of war-time requirements was, especially in its early stages, largely planned and carried out by psychologists who had been trained at the Institute or by teachers who had had some psychological instruction in their college courses or had gained experience of psychological methods in schools or elsewhere.

As the writers point out, these early educational influences should make it both easy and appropriate for the knowledge gained from the work in the Forces to be re-applied to current educational problems. The application of such methods to industry is bound to be slower, more tentative, and far less systematic. What is possible in the school or in the fighting Services under war-time conditions is scarcely feasible in the factory or the office. Nevertheless, the results which the writers report in their own particular spheres demonstrate beyond all question that, provided the limitations of the methods are realized and the actual work is supervised by trained psychologists and not by amateurs, then a vast improvement in general efficiency can be secured by a scientific scheme of personnel selection.

Perhaps the most valuable part of the book is the chapter of conclusions. In the form of forty concise generalizations, the authors have brought together the main theoretical and practical inferences which they believe can be deduced from their data and their general experience. Their survey should be of the highest value, not only to those who are continuing the work in the Services, but also still more to those who are concerned with building up similar schemes in education, industry or government departments.

## The British Pharmaceutical Codex, 1949

(Published by direction of the Council of the Pharmaceutical Society of Great Britain.) Pp. xxv+1562. (London: Pharmaceutical Press, 1949.) 63*s*.

THE new "British Pharmaceutical Codex" which was published on October 17, thirteen months after the new "British Pharmacopœia", is the fifth of the series which started in 1907. The Codex was originally based on a simple "Formulary of Unofficial Remedies" which had been issued under the ægis of the British Pharmaceutical Conference since 1886. It has grown in importance and now includes standard tests for the purity of drugs which are not included in the "British Pharmacopœia", either because they are not yet sufficiently established, or because they have been ejected. It also includes all the drugs in the Pharmacopœia with a brief summary of their properties and a large number of prescriptions.

The Codex is a more human document than the Pharmacopœia, which makes poor reading matter. The section in each monograph devoted to actions and uses has always been interesting; in the new Codex it is also reliable and up to date. Much work must have gone into the revision of these articles, which provide a valuable guide to modern therapeutics.

Among the hundreds of new preparations now included for the first time in the Codex are folic acid, dimercaprol (*BAL*), lachesine, maphenide, proguanil ('Paludrine') and various preparations of human blood, such as whole blood, plasma and serum (liquid and dried), fibrinogen, fibrin foam and thrombin. About 350 preparations have been deleted, but a brief summary of their properties is given in an appendix. A list of proprietary names for official drugs is printed on a separate card. The external appearance of the book is similar to that of its immediate predecessor, but the type and layout have been improved, and although there are more words, there are fewer pages. The Codex Revision Committee is to be congratulated on its work, which has been efficiently and promptly done. The Codex will maintain its position as an indispensable book of reference for anyone who is interested in the practical use of drugs in therapeutics. J. H. G.

## Faraday's Encyclopedia of Hydrocarbon Compounds

Compiled by Dr. Joseph Escott Faraday. Vol. 5: $C_{10}H_{6-14}$, covering the Literature up to Jan. 1, 1947. Pp. xxi+312. 1948. £5 10*s*. Vol. 6: $C_{10}H_{16}$, up to Jan. 1, 1947. Pp. 449. 1948. n.p. Vol. 2: $C_6$ and $C_7$. Second Replacement-Addition issue, up to Jan. 1, 1948. Pp. 232. 1949. 37*s*. 6*d*. Vol. 3: $C_8$. First Replacement-Addition issue, up to Jan. 1, 1948. Pp. 196. 1949. 32*s*. 6*d*. Vol. 7: $C_{19}H_{18-32}$, up to Jan. 1, 1948. Pp. 427. 1949. £5 10*s*. Vol. 8: $C_{11}H_{8-16}$, up to Jan. 1, 1949. Pp. 271. 1949. 75*s*. (Manchester: Chemindex, Ltd.)

DURING the past year and a half, Dr. J. E. Faraday has continued his great task of indexing the hydrocarbons, the volumes dealing with $C_{10}$-$C_{22}$ and $C_{11}H_{8-16}$ now having appeared. All these volumes remain virtually unchanged in plan and contain all literature references to about a year before the date of publication. Replacement-addition volumes have also appeared for $C_6$, $C_7$ and $C_8$, covering the literature up to the beginning of 1948.

An important modification for future volumes is mentioned in the foreword to the volume on $C_{11}H_{8-16}$: it is announced that in order to save space and expedite future publications, information contained in Beilstein's "Organische Chemie" and Egloff's "Physical Constants of Hydrocarbons" will not be given except as page references to these works. This seems to be a good idea, as almost all users of the encyclopædia will have easy access to these. It is also stated that as Dr. Malcolm Dyson intends to modify his system of ciphering, all ciphers hitherto given will be obsolete, and for the same reason Dyson ciphers will no longer be given until the situation is clarified. The reviewer is not aware of the changes envisaged by Dr. Dyson or of the no doubt excellent reasons which have impelled him to make them, but it is going to be troublesome if such changes are of frequent occurrence in the future.

## 'Analar' Standards for Laboratory Chemicals

Fourth edition, revised and enlarged. Pp. xviii+302. (London: British Drug Houses, Ltd., and Hopkin and Williams, Ltd., 1949.) n.p.

THIS new edition of a well-known collection of standards will be generally welcomed. Fifty-eight new items have been added, mainly organic reagents used either in inorganic analysis or in preparing derivatives of organic substances for their identification.

The adoption of improved methods and newer techniques has given increased precision in determining certain impurities. Polarographic methods, electrolytic deposition of certain metals and the Karl Fischer determination of water in liquids may be mentioned. The additional accuracy so attained is valuable: in a few instances it has shown that some previous limits prescribed were over-optimistic.

This book will continue to be a most useful laboratory handbook.

## Severn Stream

By Brian Waters. Pp. 206+16 plates. (London: J. M. Dent and Sons, Ltd., 1949.) 15*s*. net.

THIS is the sequel to Mr. Brian Waters's excellent and highly successful "Severn Tide". It deals with the upper waters of the longest river in Great Britain, from the source on Plynlimmon to Tewkesbury. This is magnificent country for the author, who is a true countryman with wide interests in topography and natural history; a man, moreover, with an inquiring mind and a great interest in his fellow men, their works and ways. Mr. Waters has made the most of his opportunity, and has written another volume of topographical writing at its best—accurate, urbane, artistic, earthy.

The reviewer was born hard by Plynlimmon, and returns to that magnetic mountain as often as he possibly can. He has not read a more perfect description of the source of Severn than that in this book, accurate even down to the detail of the buzzard's shadow magnified on the hillside, but alive with a feeling for place that is all too rare nowadays. It is so all the way down the stream. History and natural history, archæology and industry, all have their place, and no good story is missed. That would be equally true of many a topographical work of the present day. It is the warm personality of the author, and a mastery of English prose, that lifts this book, as it lifted its predecessor, away above its fellows. The sixteen photographs are excellent and well chosen, and there is a good index. Unfortunately, and incomprehensibly, there is no map. If ever a book needed a good map, it is this.

# LIVERPOOL SCHOOL OF TROPICAL MEDICINE

## FIFTIETH ANNIVERSARY

ON November 22 a reception was held at the Liverpool School of Tropical Medicine on the occasion of its fiftieth anniversary. During the ceremony the Mary Kingsley Medal was presented to representatives of the families who had helped found and maintain the School in its early days, and to scientific workers who had advanced the knowledge of tropical disease. The latter included Emeritus Prof. D. B. Blacklock, Prof. P. A. Buxton, Prof. Neil Hamilton Fairley, Dr. A. F. Mahaffy, Sir Philip Manson-Bahr, Sir Edward Mellanby, Prof. Jerome Rodhain (Antwerp), Dr. Paul F. Russell (U.S.A.), Prof. H. E. Shortt, Brigadier J. A. Sinton, Prof. N. H. Swellengrebel (Amsterdam), Prof. W. H. Taliaferro (U.S.A.) and Prof. Warrington Yorke (posthumous).

At the end of last century the toll of diseases among Europeans in the tropics was disastrous, and in this respect the British Empire was no exception; in Sierra Leone, for example, the annual morbidity-rate had at one stage reached the fantastic figure of one in three. This was in strange contrast to what was happening in Europe, where the introduction of sanitary principles based on the newly won knowledge of the cause and spread of disease was producing notable results.

Knowledge of this sort was still very little advanced in the serious diseases of hot climates, such as malaria and sleeping sickness. The necessity for organised research was obvious and, largely following the repeated insistence of Manson, Joseph Chamberlain, then Secretary of State for the Colonies, appealed in 1898 to the nation for the establishment of centres for the study of tropical disease and the training of medical men for the Colonial Empire.

Liverpool responded at once. On the inspiration of Alfred Jones, head of the Elder Dempster Line of shipping, a meeting of local commercial and medical interests was called, and in April of the following year, 1899, the Liverpool School of Tropical Diseases, as it was then called, came into existence in the Royal Southern Hospital. Alfred Jones became the first chairman, and the long association with the University began with the simultaneous appointment as dean of Rubert Boyce, the professor of pathology in the then University College.

At first the School carried on without government recognition or support; but this came soon after the turn of the century and was followed by affiliation with the University. Since then the School has grown steadily in size and strength and is recognized to-day as a world-famous institution which has played a very important part in medical research. It now houses four departments, and the staff includes three University professors.

The early work of the School was made possible by the enthusiasm of Liverpool business men, who encouraged and financially supported expeditions to the tropics in which work was carried out that formed the basis for much of the modern progress in tropical medicine and hygiene.

The School was particularly fortunate in its early choice of staff and was given a splendid start by the appointment of Ronald Ross—later Sir Ronald, and Nobel prizeman—as the first lecturer in tropical diseases. Ross was already well known for his share in the discovery of the carriage of malaria by mosquitoes—a discovery which quickly revolutionized methods of control of the disease, and in the year he was appointed took the School's first expedition to Africa, where he quickly confirmed the existence of infected mosquitoes. From the beginning, Ross emphasized a point of view that has always been predominant in the School's outlook. He regarded tropical disease as basically a sanitary problem. It was the prevention of disease that mattered, and all other research into cause and cure alike must be ultimately subservient to this aim. Ross joined the School as lecturer in tropical diseases and was eventually made its first professor of tropical medicine; but his outlook was clearly expressed when in 1913, the year before he left for London, he vacated this chair in favour of a new one created for him in tropical sanitation.

From the turn of the century until the First World War, expeditions to the tropics were vital to the progress of the knowledge of tropical medicine, and the School organised and equipped many of them. But as the material and information acquired steadily accumulated, more and more scientific work became possible in the School and its offshoot at Runcorn, and in work of this sort the staff rapidly made a world reputation which they have maintained to this day.

The scientific work has continued without a break for the whole period of the School's history; but over this time the relations of the School to the tropics have somewhat changed.

In 1905 an outstation was established at Manaos on the Amazon and for many years the work on yellow fever, in the study of which the School was early concerned, was largely concentrated there. In 1921 the School entered upon a more ambitious venture and founded a laboratory in Freetown, Sierra Leone, made possible by a further bequest from Alfred Jones.

This opened up a new phase in the School's work, for the laboratory was placed under the control of a director who was also a member of the School staff and, later, a University professor. This meant some degree of reciprocity between the parent body and its Colonial station which proved of immense benefit to both. The School now directed its work mainly to the west coast of Africa, and thanks to a series of brilliant directors the attack on local disease problems directed by the laboratory was given a unique continuity which was broken only in 1941 by the impact of the Second World War. This laboratory has remained closed for eight years, and its work both in research and in acting as a centre for medical thought and teaching on the west coast of Africa has been sadly missed. It is probable that it may soon be reopened, this time under government control, as part of a planned drive against tropical disease such as Chamberlain, in his original appeal, might scarcely have dared contemplate.

This illustrates the third phase in the School's history, for, since the Second World War, the prob-

lems of tropical disease have become recognized as world problems, and the attack on them is at last becoming an international one, directed by the World Health Organisation. It seems likely that the days of locally supported scientific expeditions and tropical outstations may be over. The future lies in linking up not only the resources of cities like Liverpool, and London, which recognized the need for action by founding a School shortly after Liverpool, but also the resources of nations vitally interested in the welfare of the tropical world.

The scientific work of the School has been vigorous and productive. Ross's achievements in the field of transmission and control of malaria, started before he joined the School and brilliantly continued for many years afterwards, have long since received world recognition. His early associates, who continued at the School after he left for London, were also remarkable men. They included Newstead, an entomologist of international repute, and Stephens, who discovered *P. ovale*, the fourth form of human malaria parasite; but the greatest of them was Warrington Yorke, who died so recently as 1943, and will be remembered as one of the pioneers of the scientific and rational study of the action of drugs on parasites.

Basic research in the School's laboratories was given a new turn in 1929 by Yorke's discovery of techniques for maintaining trypanosomes *in vitro* and the use of this method for screening trypanocidal activity of chemical substances. From this work came the study of synthalin and ultimately the development, in association with May and Baker, Ltd., of the diamidine compounds which have been used with such success in the control and early treatment of sleeping sickness, and in the treatment of kala azar. The development of this new approach to the study of the action of drugs on parasitic infections was in a way an extension of the earlier work in the School initiated by Wolferstan Thomas, who first demonstrated the action of organic arsenicals on the trypanosome infection in animals, an observation which influenced Ehrlich's work on syphilis and led indirectly to the modern tryparsamide treatment of trypanosomiasis.

The chief value of Yorke's work lies in the part it played in founding modern chemotherapy, and to some extent on its effect on the battle against disease in the Second World War, for it was largely due to Yorke that, when Java was overrun in 1942, the Allies were able to substitute mepacrine for quinine in the control of malaria, and it was his inspiration that led to the work in Imperial Chemical Industries, Ltd., Manchester, which eventually gave rise to 'Paludrine'.

No attempt could be made here even to outline the scientific achievements of the School. It will suffice to mention only a few: the original discovery of *Trypanosoma gambiense* in the Gambia by Dutton, at the time a member of the School staff; the classification of trypanosomes and separation of *T. rhodesiense* from *T. gambiense* by Yorke and Blacklock; the researches by Newstead and others on the carriage of sleeping sickness by tsetse flies; the brilliant entomological studies of Miss Alwen Evans and Patton; the demonstration by Blacklock of the carriage of the blinding worm disease onchocerciasis by *simulium* flies; researches on typhus, relapsing fever, blackwater fever and malaria, including Yorke's pioneer work on therapeutic malaria in general paralysis.

Present-day work continues on similar lines, but the emphasis has changed. Techniques have improved and a great deal of work once necessarily done in the field can now be carried on in the School's insectaries and aquaria under controlled conditions. A certain amount of research is necessarily based on the need for practical applications of methods of hygiene and control of disease in the tropics, and of the treatment of disease; in this respect the School functions as a co-ordinating link between field work and the laboratory. But research into problems of a more fundamental nature is recognized, as it always has been, as one of the essential academic functions of the School. Interest in blackwater fever and malaria, for example, is as great as ever, but is now concentrated upon the study of the physiological effects of these diseases on body tissue, an approach which has already had its influence on general medicine in at least two important aspects, namely, the recognition of the syndrome of renal anoxia, and the study of the pathogenesis of liver necrosis in a wide variety of disease conditions. Recently such work received great impetus by a further example of the generous interest taken in the School by local commercial concerns when the firm of John Holt (Liverpool), Ltd., gave a considerable grant towards the development of basic research in malaria.

Teaching is an essential part of the School's activity, and has been since Joseph Chamberlain first called for centres in which Colonial medical officers could be trained. To-day a remarkably international group of students passes through the laboratories and wards, working for the University diploma in tropical medicine and hygiene. Scientific men and technicians are trained in the laboratories and wards, and there is little doubt that the School will be called on to play a part in the production of similar personnel for the new Colonial universities. Undergraduate teaching of veterinary parasitology and postgraduate training of nurses are also part of the School's academic work.

Important clinical work goes on in the wards attached to the School, and it is not surprising that this aspect of the work was of great national value in both World Wars, and has led to advances in the control and treatment of tropical disease. In the First World War the School's buildings (the present ones) were handed over to the Government as a hospital, and the treatment of malaria by quinine was rationalized by Yorke. In the Second World War the School organised the biggest centre for tropical diseases ever seen in Britain, and in its wards 'Paludrine' was first tried against malaria. The centre for tropical diseases established then still exists.

The School has always maintained a close contact with other bodies responsible for medical research. It has received much support from the Medical Research Council and the Colonial Office; members of the staff are actively engaged in various Colonial welfare and development schemes and sit on many advisory committees, including the Colonial Advisory Medical Committee, the Inter-University Council for Higher Education in the Colonies, and the Colonial Medical Research Committee. Two of the staff were recently appointed to the new Panel of Consultants set up by the Secretary of State jointly with the Nuffield Foundation.

For the past twenty-five years the School has been honoured by His Majesty the King, first as president and afterwards as patron.

# HUMAN PROBLEMS OF WORK DESIGN

SAMUEL JOHNSON once observed how quietly people will endure an evil which they might at any time very easily remedy; he gave as an instance a family which had possessed an island for more than four hundred years and never made a commodious landing-place, though a few men with pick-axes might have cut a staircase out of the rock in a week's time. At the recent meeting of the British Association at Newcastle upon Tyne, Section J (Psychology) held a discussion on the "Human Problems in the Design of Machinery and Working Methods", and it was emphasized that, although knowledge is increasing, even modern communities have as yet little scientific understanding of these questions. In fact, Dr. Johnson's remark still holds good to-day, because many instances were quoted at Newcastle in which ordinary common sense has been lacking in the planning of the physical, psychological and social environments in which men work.

Dr. N. H. Mackworth (Applied Psychology Research Unit of the Medical Research Council, Cambridge) said that the first step is usually to identify really troublesome factors in the working situation, and that often this cannot be done by just a verbal description. A reliable diagnosis of the causes of reduced ability often depends on a careful, systematic and graded series of quantitative tests in the laboratory to study measurable changes in human performance, when the effects of many possible causes have to be disentangled. The physical dimensions of the human environment are varied in these tests to see how the human ability of healthy men fares in the new situation. Instances of this approach were chosen by Dr. Mackworth from very simple forms of work. An investigation was quoted in which the distance between the subject and his reading material was increased, and the maximum distance determined at which the material became difficult to read. Since there was clearly also a minimum distance at less than which the material again became difficult to read, there was obviously an optimum range for the reading distance within which alterations in this one physical factor made no difference at all to reading performance.

Just as in a visual experiment one can be too far from or too near the object of regard, clearly one can be too cold or too hot for effective work. In other words, this indifference range for the reading distance can readily be compared to the range of variation possible in the thermal environment without any measurable influence on human ability, although such changes are, of course, easily perceptible. Field tests far below the lower limits of this thermal indifference range were described in which the extremely cold, dry atmospheres of $-25°$ C. to $-35°$ C. gave considerable, but temporary, tactile changes in the fingers during three minutes of exposure. These sensory changes are particularly affected by differences in wind velocity, and an increase in wind speed from 0–2 m.p.h. to 6–10 m.p.h. gives a four-fold increase in the amount of this numbness at such low temperatures. There are also signs that local cold-acclimatization can occur in the hands, since less numbness is measured in men whose ordinary duties entail daily exposures to very low temperatures. This acclimatization effect is found with moderately severe wind conditions, and can be demonstrated only in this highly specific environment. Brief mention was made of the effects of high atmospheric temperatures on human ability, with particular emphasis on the laboratory findings that graphs of errors in performance either in mental or muscular tasks give logarithmically shaped curves when plotted against room temperature. The critical room temperature above which physical and mental human ability is usually reduced in laboratory tests is about 93° F. dry bulb and 83° F. wet bulb; temperatures about this level are not unknown in coal mines in Great Britain.

Dr. Mackworth then went on to describe the influence of a further physical factor—the effects of the time allowed to do the work. Some mention was made of researches on the results of allowing too much time to complete a task, especially as regards the loss of accuracy following boredom effects in visual look-out duties, but most emphasis was laid on situations where time is too short. Reference was made to the influence of speed stress (as demonstrated in the unpublished work of Vince and Conrad respectively) in terms of its effects on accuracy of simple manual movements, and on accuracy of reporting visual signals from a multiple-dial display. Comparisons were made between these results and the findings with a high-speed mental task in which the time allowed per decision is gradually reduced. Speed stress in mental tasks has been shown also to depend partly on the mental load, that is, the number of separate streams of incoming signals requiring simultaneous consideration. When increased, this mental load factor can raise the average error score, even if the number of decisions per minute is kept constant. Evidence of this kind suggests that work design need not be limited to manipulative tasks; a further detailed mathematical analysis of human behaviour is feasible, and this might even assist in the planning of more intellectual forms of work. This approach would open the way for much-needed studies of more complex aspects of human behaviour.

Another likely trend for future laboratory researches is the extension of the idea of work design to conserve human effort in ill-health; for example, in patients with limited energy as a result of chronic heart disease. Common-sense rules have already been outlined for this condition by the New York Heart Association, and further quantitative experimental work is now urgently required on this and similar problems of the design of the environment to suit some given bodily disability. Since good work design can also at times prevent accidental injuries and deaths, the practical aspects of this actively growing research subject are three-fold: an easier working task for the healthy man, a more agreeable and longer life for the sick man, and the prevention of minor and fatal accidents. A great deal of information of more general interest can also be simultaneously gathered from such studies to contribute towards the limited store of exact theoretical knowledge so far available on human behaviour.

The next speaker, Dr. C. B. Frisby (National Institute of Industrial Psychology, London), outlined three ways in which occupations may affect people: the physical requirements, the psychological constraints and the social demands. The physical demands of work have been studied for years by applied psychologists, industrial physiologists and production engineers. Movement study methods have given rather *ad hoc* information which is not sufficiently concerned with the principles of the

subject; nevertheless, much highly specific information has been obtained on this aspect. Psychological aspects of work design deal with work simplification problems by reducing the physical effort entailed, and by avoiding so far as possible the need to make decisions and exercise judgment. Due attention has, in fact, been paid to the need to reduce cognitive effort, for example, by supplying working materials in the fixed and predetermined order in which they would be required. Not enough research effort has, however, gone into studies of the psychological aspects of work design as regards the emotional aspects of occupations, as, for example, the motivation and satisfactions derived from the working situation. The social influences in occupations include factors such as (1) the effects of grouping people together at their work in different ways; (2) the result of particular methods of payment by results, in which the work of one man can at times largely determine the payment received by the whole of his group; and (3) the restrictions on social activity imposed by barriers to hearing and seeing.

Dr. Frisby held that an analysis of the workers' motivation and satisfactions with their work is of fundamental importance. So far, the attention of sociologists has been directed mostly towards questions of policy and management, and, important though these are, it is unwise to neglect the study of the job itself. Very seldom is the worker consulted about the working methods he has to employ. This emphasizes the element of compulsion and handicaps the sense of participation in the enterprise. The opportunities for creative expression are also reduced by a greater and greater subdivision of work, which means that the visible change in the material made by any one operator becomes smaller and smaller. Social compensations in the work-place make up for this, particularly with women workers, and propaganda on the social value of the finished product can also indirectly counteract this drawback. Short of actual creative expression there are often, however, strong satisfactions to be gained even with fairly simple tasks from a pride in skill. Much work remains to be done, however, on the size of the unit work cycle and the complexity of the task to determine the critical point on subdividing the work at which even this pride in skill disappears in those who are normally so employed. It is thought that this critical point may depend to some extent on the level of intelligence and special aptitude of the individual worker.

A sense of achievement can be fostered by remembering that the quantity of work issued as a batch to the workman often acts as a milestone. This target should, therefore, not be too distant, since it is known that the rate of work is often higher with smaller batches. The National Institute of Industrial Psychology is working for the Human Factors Panel of the Committee on Industrial Productivity under the chairmanship of Sir George Schuster on these two related questions of the best size for the unit work cycle and the best size for the batch supplied.

Sociological effects also arise from special production systems with subdivision of the work, because it usually means that the work is done by a group of workers rather than by one person. Differences between the working speeds of different workers often have the effect that the speed of the group is set by the slowest member. When the conveyor belt is moving quickly because the work has been broken up into short tasks, such difficulties are very likely to arise; and for this the provision of small buffer stocks of raw material between operations or groups of operations is often helpful. The possibility of more variety in work also needs consideration. For example, workers in a team might change jobs at certain stages in the day, or a worker might regularly conduct two or more processes alternately, changing at regular time intervals or on finishing a batch of work. Such systems are often more acceptable when introduced at an early stage of training so that the method is taken as a matter of course.

Dr. Frisby maintained that many sources of satisfaction exist in the work itself, which are as yet unexplored and unclassified by research investigators. It was possible that kinæsthetic sensations provide one example of this type of satisfaction, and L. G. Fuchs, the blind investigator, has made some preliminary studies along these lines. Many more researches are, however, required to study these important questions related to the satisfactions to be found in the work situation itself.

The last paper was by Wing-Commander H. P. Ruffell Smith (Royal Air Force Institute of Aviation Medicine), who emphasized that man's use of hand tools has evolved their traditional sizes and shapes over thousands of years. But the advent of the machine tool and of powered transport has quickly stressed the urgent and immediate need to fashion these new types of implements to fit the abilities of man much more exactly. One reason for this evidence of the neglect of work design is that the users of such elaborate tools cannot easily take part in their design or construction. Secondly, great technical advances in machinery have at first hidden the fact that correctly designed equipment may add even more to the speed and quality of work obtainable with these new devices. A third reason for the lag in the application of principles of work design is that people sometimes tend to choose tools by appearance rather than by function.

During the War, many flying accidents were due to faulty design of aircraft. This was because, in flying, any error due to the misuse of a control or the misreading of an instrument could easily lead to abrupt disaster. The Royal Air Force set up a research organisation which dealt with the subject of work design under three headings: the atmospheric surroundings, the personal protection of the airman, and the work-space in the aircraft. Wing-Commander Ruffell Smith dealt in detail with questions arising in the design of the aircraft working space—matters such as the dimensions, view out, controls, information, crash protection and escape. The year 1946 saw the first serious attempt of the Royal Air Force to plan work space in aircraft. Three facts stimulated this development—war-time experience of injuries due to the crash hazards of aircraft structure, accidents due to the misuse of controls, and the advent of the ejection seat. Dr. G. M. Morant has obtained anthropometric data from a thousand pilots, particularly the maximum readings for shoulder width, sitting height, thigh- and leg-lengths, and the minimum readings for the total arm- and leg-lengths. These data suggest an ejection of path 28 in. long and 27 in. wide.

The piecemeal adjustment of one item after another in the cockpit has been found unsatisfactory, and the Cockpit Layout Committee was formed to bring together the experience of pilots, medical men, men of science and aircraft designers. A skeleton model of a single-seater cockpit was constructed in which it was possible to vary any dimension at will. Pre-

liminary discussions pointed to the importance of the following factors: the view over the aircraft nose, the distance of the eye to the instrument-panel, the distance of the eye to the gun-sight, the crash distance of structures forward of the head, adequate clearance for the ejection seat, the controls to be easily within reach, the seat height and rudder-bar positions to be adjustable. From these early data a more elaborate mock-up model was then constructed, and the position and mode of operation of some two hundred instruments and controls determined. Certain principles are now common practice and are employed in all new aircraft built for the Royal Air Force, the Royal Navy and for civilian air lines. Standardization has also been agreed with the United States Services except for a few items. These important principles are (1) separation of controls into pre-flight and flight; (2) the separation of flight controls into throttle and control-column sides; (3) the distinction of controls by position, method of operation and knob-shape; (4) emergency and stand-by controls to be an over-action of the normal control or placed near the normal control; (5) controls to act in the expected direction, and the position of control surfaces to be indicated in the same way; (6) all controls to be set up forward for take-off; (7) standardization of the arrangement of flight instruments, and all engine-monitoring instruments to be arranged for rapid appreciation.

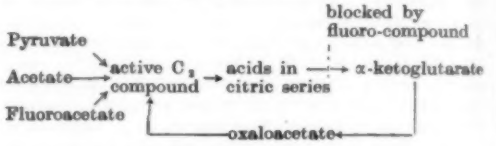
Much other work has been done on this problem of making man and aircraft a harmonious team; the tasks of other crew members are now being studied—those of the navigator, the flight engineer and the radar operator. New problems are, however, constantly being set by the swift evolution of aircraft and other equipment. These rapidly changing requirements stress once again the need for investigations directed towards discovering the principles of the subject, rather than for studies which are only *ad hoc* investigations. N. H. MACKWORTH

## BIOCHEMISTRY AND PHYSIOLOGY OF THE CELL

AT the meeting in Newcastle upon Tyne of Section I (Physiology) of the British Association on September 6, the presidential address on "The Cell" by Prof. R. A. Peters was followed by a group of papers on particular aspects of cellular physiology. Prof. Peters emphasized that recent work upon organised enzyme systems has already produced therapeutic results. In illustration, he chose two poisonous substances, iodoacetic acid ($I.CH_2.COOH$) and fluoroacetic acid ($F.CH_2.COOH$), which have similar chemical structures but very different types of biochemical action. The iodine atom of the iodoacetic acid can easily take part in substitution reactions at neutral *p*H values, whereas the C—F group in fluoroacetic acid is very stable.

Iodoacetate owes its toxic properties to its ability to combine with —SH groups in certain enzymes, such as the triosephosphate dehydrogenase of muscle which is particularly sensitive, so that when muscle tissue is poisoned with this substance, lactic acid formation is completely stopped. The oxidation of pyruvate by the pyruvate oxidase system also depends upon —SH groups, but in this case a specific poison is to be found in the arsenical lewisite ($CH.Cl : CH.AsCl_2$), which attacks a specially arranged dithiol grouping. Its action can be reversed by British anti-lewisite (BAL) (dimercaptopropanol), which is now used clinically as an antidote in cases of arsenical dermatitis and other similar conditions. Since the pyruvate oxidase requires thiamin pyrophosphate as a co-enzyme, vitamin $B_1$ deficiency induces a biochemical lesion affecting the same enzyme system.

Fluoroacetate, which is the toxic principle of the South African plant known as 'gifblaar' (*Dichapetalum cymosum*), is very poisonous indeed, especially to mammals. Its toxic action is exerted on the central nervous system and on the heart, but is not due to the liberation of fluorine. Fluoroacetate has no action on any known isolated enzyme system, but it decreases the oxygen uptake of slices of kidney tissue and causes an accumulation of citrate. Such an accumulation of citrate is also found in the tissues, especially the heart and kidneys, of animals poisoned with fluoroacetate. Citric acid and related 6-carbon tribasic acids are formed in the operation of what is known as the citric acid cycle, being produced by the condensation of oxaloacetate with an active 2-carbon compound formed from pyruvate or even from acetate. The acids of the citric series, including *cis*-aconitate, then give rise to α-ketoglutarate, which in turn forms succinate and finally oxaloacetate, which starts the whole cycle again. Prof. Peters suggested that fluoroacetate does not compete with acetic acid for entry into the citric acid cycle, but that it is activated by the same enzyme as acetate and, in fact, enters the cycle. Since the foreign molecules so formed cannot be handled by one of the enzymes at the tricarboxylic acid stage, the foreign molecule jams the cycle and so leads to a gradual accumulation of citrate. Fluoroacetate is therefore poisonous, because it is so like a normal metabolite that the tissue enzyme concerned cannot distinguish between it and ordinary acetate.




The toxic actions of both iodoacetate and fluoroacetate can therefore now be explained on the basis of modern enzyme biochemistry.

Prof. Peters next turned to the question of the biochemical organisation of the cell and the location of the organised complexes of enzymes. Many such complexes are to be found in the granules in the cell cytoplasm where they may be arranged, not in a haphazard manner as if the granule were a mere bag of enzymes, but in a regular orientation of structurally related enzymes, spatially distributed in relation to each other in an appropriate pattern which can be upset by biochemical methods. In this arrangement, surface factors play a fundamental part even down to a molecular level, and the surfaces of separation in the cell may have an individual organised structure.

Any hypothesis of cell organisation has to explain the ability of the cell to conduct, at the same time, various chemical reactions which individually require quite different physico-chemical environments, that is, the cell has to act as a 'micro-kitchen' as postulated by Hofmeister, in which, among other things, enzymes with very different *p*H optima have to act har-

moniously together. Some apparent difficulties in relation to *p*H requirements for different enzymes can be eliminated if the site of enzyme action is confined to internal surfaces, and Prof. Peters stressed the dominant part played by surface structure, especially internal surface structure, where microheterogeneity may extend down to very fine limits.

It is also necessary that the cell should react as a whole to a stimulus applied to any one point on its surface. This may be related to the presence within the cell of a sub-microscopic organisation or mosaical three-dimensional structure capable of acting integratively. While the term 'cytoskeleton' may be applied to such an organisation, it does not indicate an inert structure so much as a co-ordinating mechanism which need not be many molecules thick.

Prof. Peters referred to recent suggestions that the gene might be considered as an enzyme, but suggested that enzymes themselves need not be regarded as the primary structure, which might rather be a protein or nucleoprotein groundwork characteristic of the individual cell, to which the enzymes are attached. Such a hypothesis is supported by recent work on paramecin, on plasmagenes and on skin grafting. While many of these problems may eventually be solved with the aid of the newer techniques of chemistry and physics, it will not be possible to dispense with scientific workers whose training is fundamentally biological. (See also *Nature*, Sept. 3, p. 393.)

The next speaker, Dr. R. Barer, emphasized that the concept of the microscope as a mere magnifying glass is being replaced by the realization that it can be used as a valuable physico-chemical tool. One of the major difficulties encountered in the study of the living cell is its great transparency to visible light; but this problem has been largely solved by the development of phase-contrast microscopy, which converts changes of refractivity into corresponding changes of intensity and thus enables living cells to be studied under excellent optical conditions. Considerable advances are being made in our knowledge of the structure and behaviour of cells and of the action of chemical and physical agents, such as fixatives, on living protoplasm.

The primary purpose of the electron microscope is to obtain very high resolution down to molecular level. The shadow-casting technique can produce very spectacular results when it is applied to biological material; for example, it can be used to demonstrate the presence of what are believed to be contractile molecular threads within muscle fibrils. In some cases it is possible to study the structure of cell membranes and the cytoplasm of cells grown in tissue culture. The reflecting microscope is completely achromatic and can therefore be used in the ultra-violet, visible and infra-red regions of the spectrum without change of focus. This has enabled adsorption spectroscopy of cells, fibres, crystals and other materials to be carried out in a spectral range extending from 230 mμ to 14 μ. The use of ultra-violet and infra-red polarized light in conjunction with such spectroscopic methods has yielded particularly interesting information on the chemical organisation of crystals and orientated fibres. The reflecting microscope is a unique instrument for the correlation of chemical and structural organisation, and its possibilities are very far from being exhausted.

Prof. J. N. Davidson pointed out that the various components of the cell can now be separated by means of differential centrifugation, which yields from the cytoplasm particles of two main sizes. The smaller particles, or microsomes, are ultra-microscopic in size, but the larger particles correspond to the mitochondria, or secretory granules, and a modern technique of homogenization and centrifugation in molar sucrose solution results in the isolation of morphologically intact mitochondria. These cytoplasmic particles contain protein, lipid and ribonucleic acid—the nucleic acid content being greater for the smaller particles. Certain enzyme systems are located in these cytoplasmic granules and the succinoxidase–cytochrome oxidase system, and the enzymes of the tricarboxylic acid cycle are to be found almost exclusively in the large particles. By virtue of their nucleic acid content, such particles can conveniently be studied by means of ultra-violet microscopy, which can also be made the basis for the photometric estimation of minute amounts of nucleic acid in different parts of the cell.

The cell nucleus contains a basic protein—either protamine or histone—a non-histone protein containing tryptophan (the chromosomin of Stedman) and both types of nucleic acid. Ribonucleic acid is present in only small amounts and appears to be located mainly in the nucleolus; deoxyribonucleic acid, on the other hand, is abundant in the cell nucleus, but the proportion found in dried nuclei depends largely upon the method of isolation, since modern techniques of preparing clean nuclei with the aid of citric acid tend to remove histone and so to cause an apparent increase in the deoxyribonucleic acid content when the nuclei are analysed in bulk. On the other hand, when the deoxyribonucleic content is expressed as an absolute amount per nucleus, very striking results are obtained. It has been shown that the deoxyribonucleic acid content of the cell nucleus is constant for the different organs and tissues in a given species, although there might be a big variation from one species to another. In general, the amount in the sperm cell nucleus is almost exactly half that found in the somatic cells. If the amount of deoxyribonucleic acid in the nucleus is, in fact, constant for a given species, it provides a standard of reference to which the other constituents and the biochemical activities of the cell might be related; and it also provides what is probably the most useful indication of cell growth, since an estimation of the deoxyribonucleic acid content of a sample of tissue will give a measure of the number of cells present.

A lipoprotein was defined by Prof. A. C. Frazer as a molecular complex of lipids and proteins possessing properties which are significantly different from the sum of the properties of its components. The linkage between lipid and protein molecules may be electrostatic, covalent or by secondary valencies. Methods used for lipoprotein studies include chemical methods, especially fractionation, microanalysis and the study of model systems; physical methods, of which X-ray diffraction techniques have proved valuable; physico-chemical methods, by which the inter-reactions of lipids and proteins at air/water or oil/water interfaces can be studied; cytological methods, which entail histochemical microanalysis or cell fractionation by ultra-centrifugation; and biological methods involving the study of cell structure and function under varying environmental conditions. The more these methods can be related to each other, the more rapidly will useful information on lipoproteins be obtained.

Using these methods, Cohn and his colleagues have separated a β-lipoprotein having spherical particles 185 A. in diameter and molecular weight of about 1,300,000, and an α-lipoprotein with particles about 300 A. long and 50 A. wide and molecular weight about 200,000. Many important lipids, such as œstrogens and carotenoids, appear to be associated with the β-lipoprotein. The chylomicrons in the blood are stabilized by a lipoprotein—the protein being linked to the non-reactant triglyceride core by lecithin. One conception of membrane structure is of a basic lipoprotein framework to which further lipid sub-units can be added to provide a lipid/protein mosaic. Mitochondria and other intracellular structures are said to be lipoproteins. The effects of solvents and dehydration on nerve myelin have been studied by combining X-ray diffraction and micro-analysis. The observations suggest the existence of lipid/protein and lipid/lipid subunits as part of a larger lipoprotein complex. Lipoproteins provide a structural medium which can accommodate both lipids and water. Association of lipid with protein may prevent oxidation—after separation, the lipid can oxidize rapidly. Fat transport in the blood is mainly as glyceride rather than lipoprotein. In general, a lipoprotein consists of a lipid/protein subunit largely dependent on electrostatic forces and particularly sensitive to *p*H changes and dehydration, and a lipid/lipid subunit in which van der Waals forces and the formation of hydrogen bonds might be more important.

Mitochondria were discussed by Dr. G. H. Bourne, who described them as rods, filaments or granules seen best by dark-ground illumination and phase-contrast microscopy, and often occupying a particular orientation in the cell as if they were arranged by currents of diffusion linked with the sub-microscopic structure of the protoplasm. They can be separated by differential centrifugation and shown to consist mainly of protein, lipid and ribonucleic acid, but they may also contain small amounts of vitamins, some pigments and certain enzymes. Most of the succin-oxidase of the cell is to be found in the mitochondria, which appear, therefore, to be intimately connected with the aerobic respiration of cells. Mitochondria are greatly reduced during starvation, but return on feeding. They are to be regarded not as semi-permanent self-reproducing cell organelles, but rather as temporary aggregates of complex composition and as a reserve store of metabolic substance for the cell.

Mr. M. M. Swann spoke of his researches with the polarizing microscope on cytoplasmic structure in the sea urchin egg, with particular reference to the changes occurring during the mitotic cycle. The highly oriented metaphase spindle and asters give way to a less oriented structure as mitosis progresses, and it appears that the agent controlling this change is liberated directly or indirectly by the chromosomes. This less oriented arrangement of protoplasmic material is normally so weakly birefringent as only to be visible with very refined methods. It consists apparently of form and intrinsic birefringences acting in opposition, and more or less cancelling out. This curious arrangement seems to obtain in rather different forms in both the fertilized and unfertilized eggs, and in other cells as well, and it is perhaps to be regarded as the 'cytoskeleton'. The asters and spindle are therefore not *de novo* structures, but modifications of a structure always present.

J. N. Davidson

## FOLIC ACID, VITAMIN $B_{12}$ AND ANÆMIA

THE programme for Section I (Physiology) of the British Association at the meeting this year at Newcastle upon Tyne included a symposium on folic acid, vitamin $B_{12}$ and anæmia. In a brief introduction, the chairman, Prof. R. A. Peters, mentioned the importance of the topic and the intense interest aroused by the synthesis of folic acid and the isolation of vitamin $B_{12}$.

The first paper, on the chemical aspects, was read by Dr. E. Lester Smith. This contribution centred round the methods of treatment of the macrocytic anæmias, especially pernicious anæmia. The first effective treatment was discovered by Minot and Murphy in 1926. Their use of raw or lightly cooked liver by mouth was quickly superseded by liver extracts given at first orally and, later, by injection, made possible by more extensive purification through fractional precipitation with alcohol and other means. Some progress towards the isolation of the active principle was made by American, Norwegian, Swiss and British biochemists; but the problem proved exceptionally difficult, mainly on account of the lack of a satisfactory assay method. The final isolation of vitamin $B_{12}$ was announced almost simultaneously in 1948 in America by Rickes and co-workers at Merck and Co., Inc., Rahway, N.J., and by Lester Smith of Glaxo Laboratories, Ltd., Greenford, Middlesex. This culmination of twenty-two years of research aroused great interest, which was increased by the announcement that the red crystalline substance had an extraordinarily high biological activity and contained cobalt in its molecule.

Some years previously, several American teams prepared, from liver, yeast and spinach, concentrates that promoted the growth of *L. casei* and other micro-organisms; they also promoted normal growth and prevented anæmias in chicks or monkeys on deficient diets. This series of researches culminated in the isolation of a crystalline substance known as folic acid or pteroylglutamic acid, which was synthesized by a large group of workers at Lederle Laboratories, Pearl River, N.Y., within a very short time of its isolation from natural sources. The great confusion that had existed over an apparent multiplicity of related factors was cleared up by the isolation of two conjugates of folic acid with an additional two and six molecules respectively of the glutamic acid radical. They have different activities towards micro-organisms, but can be converted into folic acid by specific conjugases.

It was only after synthetic folic acid became available that its efficacy in macrocytic anæmias was announced. From the high doses required, however, it quickly became apparent that folic acid could not be the effective agent in purified liver extracts. A little later it was shown that it is somewhat less effective hæmatologically than liver extract (both given at adequate dose-levels), while it is entirely ineffective against the neurological complications of pernicious anæmia.

The war-time scarcity of feeding stuffs focused attention on the fact that chicks and other farm animals need animal protein in their diet. Concentrates of an 'animal protein factor' were prepared from fish solubles and from cow manure, and gradually accumulating evidence indicated that this factor

might be identical with the anti-pernicious anæmia factor of liver. Finally, Stokstad and others showed that the animal protein factor could be elaborated by suitable micro-organisms and that the bacterial product was effective in pernicious anæmia. This discovery opened a way for production of vitamin $B_{12}$ by fermentation methods similar to those used for making antibiotics. Indeed, it was announced at the end of 1948 by the Merck group that a strain of *Streptomyces griseus* (the organism used for streptomycin production) produced vitamin $B_{12}$.

The presence of cobalt in vitamin $B_{12}$ seemed at first to link this substance with the known requirement of ruminants for traces of cobalt in their diet. Any direct connexion was disproved, however, by the discovery that vitamin $B_{12}$ was ineffective for sheep on a cobalt-deficient diet. Nevertheless, a less direct connexion may be postulated. It seems that the cobalt is required not directly by the animal but by the rumen bacteria, which play a large part in ruminant digestion. It is likely that these bacteria utilize part of the cobalt to synthesize vitamin $B_{12}$, which then finds its way into the liver of the animal.

The second paper, on bacteriological aspects, was given by Dr. D. D. Woods, of the Department of Zoology and Comparative Anatomy, Oxford, who pointed out that micro-organisms have played a worthy part in this work. All the well-characterized members of the vitamin B group, including folic acid and vitamin $B_{12}$, are now known to be essential growth-factors for some micro-organism or other. By no means all bacteria require all these factors; broadly speaking, when a factor is not required, this means that the organism concerned is capable of synthesizing it. Thus it is true of both folic acid and vitamin $B_{12}$ that certain micro-organisms require them and can therefore be used in their microbiological assay, whereas other organisms synthesize useful amounts of the factors and could be used for their production.

Microbiological assays have several advantages over the alternative animal assays for folic acid, or clinical assays for vitamin $B_{12}$. Thus the deficient media are relatively easy to prepare. The criterion—namely, growth of the organism or its absence—is simple in comparison with the assessment of symptoms in higher animals. Finally, there is usually a clear-cut relationship between dosage and response, and results are obtained quickly, often within twenty-four hours. On the other hand, it so happens that folic acid, and also vitamin $B_{12}$ especially, are among the most difficult factors to assay microbiologically. The organisms usually employed for vitamin $B_{12}$ assay are certain micro-aerophilic lactobacilli; since these do not require vitamin $B_{12}$ at all for purely anaerobic growth, quantitative response depends on the degree of aeration of the medium and careful control of the concentration of reducing agents.

Factors in the vitamin B group are required not only by bacteria and animals, but also by fungi, protozoa, insects, birds and higher plants. One may therefore conclude that they are essential metabolites for all types of cell. It follows that in studying their function one may use any convenient organism, and in practice micro-organisms are often the most convenient. The picture is still far from complete, but there are indications that folic acid may have a function in the biosynthesis of pyrimidines, thymine (a constituent of desoxyribonucleic acid) and possibly purines, such as adenine. It is also probable that folic acid functions as part of the structure of the coenzyme involved in these syntheses. It is possible that folic acid, which contains a *para*-aminobenzoic acid residue, may function like the latter substance in the biosynthesis of certain amino-acids. For vitamin $B_{12}$ the evidence is still less complete, but there are indications that it may be involved at some stage in the biosynthesis of desoxyribosides, possibly for the synthesis of the desoxyribose moiety or for its attachment to the purine or pyrimidine.

The concluding paper of the session, by Dr. C. C. Ungley, of the Royal Victoria Infirmary, Newcastle, was on clinical aspects. Dr. Ungley has assayed on some eighty patients the liver fractions that were used in the isolation of vitamin $B_{12}$ in Great Britain. His paper, however, concerned the findings on some fifty patients treated with the pure crystalline compound at various dose-levels. Confirming previous findings with liver extracts, the reticulocyte response proved a somewhat unreliable index. The increase in red blood cells conveniently assessed at the fifteenth day was much more closely related with dose. The expected response is a function of the initial level of red cells, but a statistical method was evolved to adjust the responses to a 'theoretical' initial level of two million.

It was then found that on average a single dose of 10 μgm. would produce the 'expected response', according to the accepted formula, but that larger doses gave greater responses, which were roughly proportional to the logarithm of the dose in the range 5–80 μgm. For maintenance, doses of 10 μgm. every two weeks gave satisfactory results in nearly all patients. No fresh neurological symptoms developed in any of the patients maintained for periods up to fifteen months on vitamin $B_{12}$, while cases of already established subacute combined degeneration of the spinal cord improved after continued dosage with vitamin $B_{12}$, and to the same degree that would be expected from dosage with active liver extracts. Dr. Ungley also reported several cases of macrocytic anæmia of pregnancy that responded to folic acid after failing to respond to vitamin $B_{12}$.

E. Lester Smith

---

# OBITUARIES

## Dr. A. P. Laurie

It is difficult nowadays to think back to the time when it was considered eccentric to apply the tools of the scientist to the problems of the artist—when there was no laboratory, no group of research physicists and chemists, at the National Gallery, the Louvre, the British Museum, the Courtauld Institute of Art, the Fogg Art Museum. These, and their counterparts elsewhere, owe much to one bold pioneer—Arthur Pillans Laurie, whose death on October 7 at the age of eighty-seven has deprived them of their doyen.

Born on November 6, 1861, near Edinburgh, the son of Prof. S. S. Laurie, he was educated at the Universities of Edinburgh and Cambridge. His early scientific interests lay in the field of electrochemistry; he worked on the E.M.F. of alloys in voltaic cells and kindred problems, and obtained a D.Sc. at Edinburgh. He had a keen appreciation of the fine arts; and an early contact with Holman Hunt directed his scientific interests towards the materials of the craftsman. Although he specialized in the materials employed in painting and the graphic arts, and

became an accepted authority on the technical methods of the Old Masters, his interests extended to other crafts; and his little book, "Building Materials" (1922), takes an honourable place beside his better-known works: for example, "The Pigments and Mediums of the Old Masters" (1914), "The Painter's Methods and Materials" (1926), and "The Brush-work of Rembrandt and his School" (1932).

Laurie developed many ingenious methods of investigating pigments and media on the micro scale, at a time when microchemistry had not yet become an orthodox technique, and he figured prominently in so many *causes célèbres* on the authenticity of Old Master paintings that his eminence in this sphere is in danger of obscuring the catholicity of his other interests. As a young man he worked in Whitechapel under Canon Barnett, at Toynbee Hall; clubs, theatres and gardens for the young East Ender, and a precarious little factory for improved artist's colours, all engaged his energies at this time. A fervid Liberal and friend of Lloyd George, he once contested unsuccessfully a Liberal seat in his native city. He was principal of the Heriot-Watt College, Edinburgh, during 1900–28, difficult formative years; and the impressive development of the College owed much to Laurie's devoted labours. In 1912, to his great delight, the value of his researches on the artist's materials was recognized by his appointment as professor of chemistry to the Royal Academy of Arts.

Laurie was a character. Straightforward and honest to a fault; burly in figure, brusque and gruff in manner; scholar, humanitarian, lover of the arts; pugnacious, full of vitality, stubborn and argumentative, generous and kindly; a good talker on any topic, but most of all on pictures; the ever-probing investigator, a good friend, and a stimulating antagonist; a man intensely individual and unorthodox, authoritarian yet himself impatient of authority—these are some of the memories of him which persist most vividly. On his favourite topic he wrote as he talked—rapidly, staccato, with confident authority and little inclination to revise, prune and polish; but his matter was of such novelty and interest that it was easy to forgive the brilliant *non sequitur* which now and then delighted the reader.

It caused, perhaps, less surprise than distress to the friends of this robust and authoritarian old scholar when, in his seventies, he took up the cudgels on behalf of the Nazi philosophy, even to the publication of a spirited defence thereof, "The Case for Nazi Germany". This lost him friends; characteristically, however, he did not swerve from views honestly held, however unpopular.

P. D. RITCHIE

## Prof. Alexander Meek

ALEXANDER MEEK, who died on November 2, was born at Broughty Ferry in 1865. He was for many years, until his retirement in 1932, professor of zoology at Armstrong College (University of Durham) and director of the Dove Marine Laboratory. After leaving school, he studied art and then determined to become a scientific worker. He spent a year at the Royal College of Science and then entered University College, Dundee, as a student under Prof. D'Arcy Thompson. For two years after graduating in 1889 he worked at the Gatty Marine Laboratory under Prof. W. C. M'Intosh. He was then appointed county council lecturer in agricultural zoology in Aberdeenshire. He held this post until 1894 when he obtained a lectureship in veterinary anatomy and farm hygiene at what was then the University of Durham College of Science, later to become Armstrong College and, still later, although not in his time, to be merged in the present King's College.

After his appointment at Newcastle, his interest again turned to marine zoology, and, in 1898, he was appointed to a demonstratorship in the Department of Natural History without, however, severing immediately his connexion with agriculture. He was fortunate in working under Prof. G. S. Brady, who had written the reports on the Copepoda and Ostracoda of the *Challenger* Expedition and who knew or had known the local 'giants' of marine zoology such as Joshua Alder, Albany Hancock, Canon A. M. Norman and many others. He succeeded Brady in the chair of zoology in 1908.

In this environment Meek flourished. In 1897 the Northumberland Sea Fisheries Committee published his first "Report on the Trawling Excursions carried on during the Summer of 1897 and on the Marine Laboratory at Cullercoats". The Marine Laboratory at this time consisted of cramped and inadequate quarters at the old salt-water baths in Cullercoats Bay. Using this as a base, Meek carried out many investigations into problems of the local inshore fisheries. In his report for 1904, Meek recorded the destruction by fire of the old wooden laboratory and the complete loss of records, specimens and apparatus. But he also announced the formation of a committee the object of which was to collect funds for the establishment of a new and more adequate laboratory. As the result of the efforts of this committee and especially of Meek himself, a sum of money was collected which was, however, insufficient for the purpose. The situation was saved by Mr. W. H. Hudleston, who erected the present building at his own expense. Armstrong College at first was the tenant, and afterwards purchased the Laboratory which was opened in 1908 as the Dove Marine Laboratory.

Established at last in a well-built and up-to-date marine laboratory with a good aquarium and sufficient working space, Meek launched out into many activities. The long series of annual reports which he edited and to which he contributed so largely show how few aspects of the local inshore fisheries escaped the attention of himself or his staff and students. Meek had the welfare of the fishermen at heart and he had a remarkable power of gaining their confidence. One important result of his work and influence is to be seen to-day in some of the local by-laws governing the crab and lobster fisheries.

Apart from his more strictly economic studies of fisheries, Meek covered a wide field. Much faunistic work, especially in relation to fishes and amphipod Crustacea, was published by him in the Dove Marine Laboratory Reports. His book "The Migrations of Fish", published in 1916, was an important contribution at the time and is still valuable. He was the first to point out the importance of *Sagitta setosa* and *S. elegans* as plankton indicators. He was also interested in embryology, on which subject he published a number of papers.

Meek was a man of strong personality who could inspire enthusiasm and loyalty in his colleagues and students. He succeeded worthily to the great tradition of marine biology on the north-east coast of England, and his greatest achievement was, perhaps, the establishment of a laboratory in which this work still continues.

A. D. HOBSON

# NEWS and VIEWS

## Chemistry at King's College, London: Prof. A. J. Allmand, F.R.S.

PROF. A. J. ALLMAND, whose retirement from the Daniell chair of chemistry at King's College, London, at the end of the session 1949–50 has been announced, was born in 1885 and began his studies at the University of Liverpool. Graduating in 1905, he obtained his D.Sc. in 1910, and continued his research work, as an 1851 Exhibition research scholar, with F. Haber at Karlsruhe during 1910–11 and with R. Luther at Dresden the following year. He was appointed assistant lecturer at Liverpool in 1913. Joining the Army early in 1915, Prof. Allmand went on active service to France in the summer of that year, but owing to a fortunate chance was transferred to the Gas Services in the autumn. He became chemical adviser to the Fourth Army (1916–18) and to the Second Army (1918–19), obtaining the M.C. in 1916. In 1919 he was elected to the second chair of chemistry at King's College, London, succeeding to the Daniell Chair in 1938, on the retirement of Prof. S. Smiles. In recent years he has seen important additions to the accommodation for chemical research at King's College. Prof. Allmand's researches have included many important contributions to photochemistry, electrochemistry, adsorption of gases by solids, and the structure of electrodeposited alloys. His well-known book on the "Principles of Applied Chemistry" appeared in 1912, and a second edition with Dr. H. J. T. Ellingham in 1924. Prof. Allmand was elected to the Royal Society in 1929, and has served on the Council (1936–37). He was president of the Faraday Society during 1947–48. During the Second World War he did not leave London, but worked at King's College on special war research for the Ministry of Supply (and also Imperial Chemical Industries, Ltd.). During August 1944–December 1945 he was superintendent of explosives research in the Armaments Research Department. In 1920 he married a French lady, Mlle. Malicorne, by whom he has had three children; one boy, Michael, was killed on active service during the War and won the V.C.

## Prof. D. H. Hey

PROF. D. H. HEY, who has been appointed to succeed Prof. Allmand, was born in 1904 and, after eight years at Magdalen College School, Oxford, spent the period 1923–28 as a student at University College, Swansea. In the latter year, he joined the staff of the Chemistry Department of the University of Manchester, where he stayed for ten years. During 1939–41 he taught at the Imperial College of Science and Technology, London, and then until 1945 he was engaged in industrial research. Since 1945 Prof. Hey has held the second chair of chemistry at King's College, London. His degrees include those of M.Sc. (Wales), Ph.D. (London) and D.Sc. (Manchester). He has been an honorary secretary of the Chemical Society since 1946, and is a member of the Chemical Council. He has also served on the council of the Royal Institute of Chemistry. Prof. Hey's numerous publications have appeared chiefly in the *Journal of the Chemical Society*. Many of them deal with the chemistry of diphenyl and triphenyl derivatives, and with the aryl pyridines. Prof. Hey has also been interested in chemotherapy. In particular, he is well known for his theory of the important part played, in organic reactions in liquid media, by free radicals of short life, a theory which arose out of his own work on diazo-compounds and peroxides.

## Zoology in the University of Liverpool: Prof. J. H. Orton, F.R.S.

THE retirement of Prof. J. H. Orton from the Derby chair of zoology in the University of Liverpool is announced. Prof. Orton has had a distinguished zoological career and is the doyen of marine biologists in Great Britain. He was on the staff of the Plymouth Laboratory of the Marine Biological Association from 1910 until 1929, when he was appointed to Liverpool. Before the First World War he had already done pioneer research on the ciliary feeding mechanisms of marine animals and on temperature in relation to breeding. After his return from war service, he devoted most of his attention to the biology of molluscs, more especially the oyster, on which he became a foremost authority. While at Plymouth he conducted for many years the Easter courses for university students, and many biologists will remember with gratitude his enthusiastic and inspiring encouragement in their student days. In recent years his influence has been very noticeable in the Liverpool area, especially in much ecological work which is being done on the shores of the Isle of Man and the surrounding waters. His wide knowledge of the biology of marine organisms, and especially of the British marine fauna, makes Prof. Orton a much valued member of the zoological community. All will therefore wish that he may be able to continue his researches for many years during his retirement.

## Dr. R. J. Pumphrey

DR. R. J. PUMPHREY, who succeeds Prof. Orton, has for many years been associated with or on the staff of the Zoological Department at Cambridge. Going into residence in 1925 and winning the Frank Smart Prize in 1929, he has held an unusually wide range of distinguished research appointments, including Rockefeller and Beit fellowships. Since 1946 he has been an assistant director of research and as such primarily concerned with problems of sensory physiology. He is best known for his outstanding contributions to our knowledge of the auditory and visual functions in lower organisms. Much of this work involves a highly specialized and biophysical approach; but the outstanding feature of its results is the extent to which they provide a much clearer and more convincing picture of the role of the sense organs in the everyday life of the organisms. This combination of intellectual acuity and wide-angled vision augurs well for the future of his new Department. Dr. Pumphrey is unusually well equipped to deal with the relationship of university departments to the teaching of biology in schools, for he has played a very active part in framing the syllabuses now in force for school and higher certificate examinations; with a colleague, at Manchester, not uninterested in such matters, there is little fear of undue stagnation.

For many years the Zoological Department at Liverpool has been associated with marine biology, a field which has the good fortune to place little, if any, financial strain on university departments as such; the specialized accommodation and expensive equipment necessary for experimental research has to be provided from university funds. It will be interesting to see how quickly the well-deserved sympathy of the University Grants Committee will be able to provide the legitimate needs of a new and very vigorous professor.

## British Museum (Natural History) : Acquisitions

THE Trustees of the British Museum (Natural History) have acquired, partly by purchase and partly by presentation, from Mrs. Lorna Tillotson, one half of a new meteorite which fell at Beddgelert, Caernarvonshire, on September 21. The other half is to go to the University of Durham, where Prof. F. A. Paneth plans to make measurements of the helium, uranium and thorium content to add to the present meagre data available for calculating the age of meteoritic stones. Plaster casts of the stone will be made before it is divided. The meteorite is a black chondrite, a rather uncommon type of stony meteorite. The mineral composition has not been studied at present. Its arrival was accompanied by several loud explosions likened by Mr. Tillotson to heavy gunfire. Mr. Tillotson, by noting the positions of the holes in the roof and in the ceiling of the room into which the meteorite fell, determined that the angle of its fall on to the roof was nearly vertical. Very few reports have been received about the light or sound phenomena accompanying the fall. Those so far received are from three localities in Caernarvonshire, Lancashire and Cheshire. Any records of the passage of a meteor over Great Britain or Ireland would, therefore, be of interest, and should be sent either to Prof. Paneth or to Dr. W. Campbell Smith, Keeper of Minerals, British Museum (Natural History), London, S.W.7.

The Museum has also received a collection of birds, including kingfishers, owls, pigeons and birds of paradise, and mammals, all of which were collected in New Guinea by Mr. F. Shaw-Mayer. Mr. Michael Cox has presented a collection of 114 beautifully preserved plants, which he made in a largely unexplored area of north-west British Columbia, and which includes flowering plants, mosses, liverworts, lichens and fungi. 8,300 microscope slides illustrating the anatomy of the genus *Equisetum*, and forming the collection made by the late Lady Isabel M. P. Browne, the leading authority on the anatomy of this genus for many years, has been received through Prof. F. W. Jane, Royal Holloway College, University of London. Prof. W. T. Gordon, recently professor of geology, King's College, London, has presented minerals and rocks from various localities in South Africa, Novaya Zemlya and Russia. Three pieces of the meteoric iron from Canon Diablo, the famous meteorite crater in Arizona, have been received from Mr. Richard W. Barringer, of Philadelphia. An interesting collection of crystalline masses of orpiment (arsenic trisulphide) from the Herja mine, Chiuzbaia, Rumania, has been purchased; the collection represents the whole of the first find of this mineral at Chiuzbaia (formerly Kisbanya, Hungary).

## Wellcome Historical Medical Library

THE re-opening, at the Wellcome Research Institution, 183 Euston Road, London, N.W.1, of the Wellcome Historical Medical Library was marked by a luncheon attended by a number of distinguished librarians and others interested in the history of medicine and the allied sciences. After the luncheon, an address was given by Dr. Ashworth Underwood, director of the Library and of the Wellcome Historical Medical Museum. Dr. Underwood recalled that both the Library and the Museum had been built up as a private interest by the late Sir Henry Wellcome. The Library consists of more than 200,000 volumes, many of which are extremely rare. The collection of *incunabula* (books printed before the end of the fifteenth century) contains 632 volumes and is the second largest collection of medical and cognate *incunabula* in the world. Equally important is the sixteenth-century collection, which contains a number of hitherto unrecorded works. Sir Henry Wellcome began his collection about 1895, and thereafter he had frequently added as many as two thousand volumes a year, and in one year the number reached more than five thousand. His collection of *incunabula* was commenced some time before 1897, and by the First World War he had more than two hundred and fifty. The Library is one of the world's greatest collections, built up by a single individual, and its importance for the study of the history of medicine and the sciences is very great. Dr. Underwood paid a tribute to the work carried out by Mr. W. J. Bishop, the librarian, Mr. F. N. L. Poynter, the deputy librarian, and the staff of the Library, in bringing it to its present condition.

Apart from many works of extreme value for the history of medicine, the Library is very rich in special collections; for example, works of travels (especially those containing early descriptions of tropical diseases and of the indigenous materia medica); botany; alchemy (one of the finest collections in the world); occultism; tobacco; plague; archæology; anthropology and folk-lore. In addition, there is a very comprehensive collection of modern bibliographical and reference works. The Library is for reference only, and no books can be lent. There is ample accommodation for readers, and there are facilities for photographic reproduction. Prints, lantern slides and photostat copies can be supplied, and there is also a microfilm service, with a reading machine installed in the Library. Although the Library is primarily intended for the use of students of the history of medicine and the sciences, access is freely granted to any serious inquirer. Indeed, the resources of the Library are admirably suited to postgraduate study in historical topics that are not specifically medical, and valuable information may be found touching on social history and the social sciences, religion and philosophy, literature and the arts, technology and archæology, especially Egyptian. There are also comprehensive biographical and bibliographical collections. Historical and bibliographical inquiries can be dealt with by the Library staff; these should preferably be made by letter. A general catalogue of the Library in short-title form is now being prepared for the press. Scientific and other societies can arrange for special visits to the Library, which is open on Monday to Friday from 10 a.m. to 5 p.m.

## Ultra-Violet Radiation in Industry

ON December 1 a small but interesting demonstration on ultra-violet radiation in industry was given by Hanovia, Ltd., at 3 Victoria Street, London, S.W.1. The demonstration was divided into three parts showing respectively: photochemical and photobiological reactions; fluorescence and phosphorescence; and a selection of ultra-violet lamps in stock and in current use. In the first section was illustrated the use of ultra-violet radiation for the production in a few hours or days of the effect of several years of bright sunlight, by which means the deterioration of dyes, paints, varnishes, metal surfaces, etc., can be rapidly tested. Other photochemical reactions included the polymerization of methyl methacrylate for joining 'Perspex' sheets, the isomerization of ergosterol into calciferol (vitamin $D_2$)

and the application of ultra-violet for rapid photo-printing. The radiation is also used for its germicidal properties in sterilizing atmospheres and in the brewing, bottling and other food industries. Fluorescence of materials under ultra-violet radiation has many applications, such as the testing of fabrics (particularly for invisible oil-spots before dyeing), in forensic medicine and for partition chromatography. The addition of fluorescent tracers in plumbing systems, etc., for observing leaks and flows is of great importance, since the detection of one part in $10^8$ can be achieved. Most of the above-mentioned work can be done with lamps of the extra-high pressure type (mercury-filled at pressures of 6,000–2,000 mm. of mercury) and high pressure type (2,000–600 mm.), the rays of which do not affect the skin or eyes and can be refracted by glass lenses and prisms. The spectrum for the high-pressure type is almost continuous at about 2800–3200 A., and the extra-high type is the same but with the wave-length energies displaced slightly towards the long end. For certain work, particularly for geological purposes, low-pressure discharge tubes (10–0·1 mm. pressure and almost monochromatic at 2537 A.) are used, and the radiation from these burns the skin and can only be refracted by quartz. Specimen lamps of all three types were shown, both mains-driven and battery-portables for field work being included.

## Proposals for International Collaboration in Applied Spectroscopy

At a meeting held in Paris on October 1, the need for an international organisation to promote spectrochemical analysis was discussed. The meeting followed the eleventh congress of the Groupement pour l'Avancement des Méthodes d'Analyse Spectrographique des Produits Métallurgiques. Besides the members of the French committee, spectroscopists representing groups in England and Switzerland were present, with others from Holland and Belgium. Discussion originated in an Italian proposal to form an international society of spectroscopists based on individual membership, and on a French proposal to form an international federation of regional or national societies of spectroscopists. It was reported that the International Council of Scientific Unions might sponsor a mixed commission on spectroscopy to co-ordinate the activities of physicists and astronomers interested in spectra, but that this body is not likely to concern itself with applied spectroscopy. After considering all these proposals, those present decided that in the first place it would be wise to work for a fuller interchange of information and speakers simply between societies in various countries organised to deal with emission or absorption spectra as applied to analysis. A list of such societies or groups and of their secretaries is to be compiled, and will be published in *Spectrochimica Acta*. This journal, which during 1946–49 was published in the Vatican City, is to be published in London from 1950 onwards. The editor, Ernest van Someren, of 4 Churchfields, Broxbourne, Herts, England, would like to receive the names of spectroscopic societies and of their secretaries, and hopes to be of service in keeping them in touch with the activities of other similar groups.

## University of Birmingham: Appointments

The following announcements have recently been made by the University of Birmingham. Appointments to the Sir Josiah Mason Lectureship are as follows: 1950, Prof. I. Schapera, professor of social anthropology in the University of Cape Town; 1952, Dr. H. I. P. Hogbin, reader in anthropology, University of Sydney. The title of reader in palæontology has been conferred on Dr. H. B. Whittington, lecturer in geology.

The following have been appointed to lectureships in the subjects indicated: F. R. N. Nabarro, metallurgy; Dr. G. F. J. Garlick, physics; Dr. M. Krook, mathematical physics; Dr. J. H. Turnbull, chemistry; Dr. W. S. Norman, chemical engineering; J. Walker, physics; Dr. Elsie A. G. Knowles, industrial statistics (Department of Engineering Production); H. Grisbrook, tool engineering and metrology (Department of Engineering Production). Research fellows have been appointed as follows: D. J. Desmond and L. A. Ferney, to be Tube Investments research fellows in the Department of Engineering Production; K. B. Mather, to be I.C.I. research fellow in physics; Dr. D. W. Wakeman, to be I.C.I. research fellow in metallurgy.

## Royal Society: Officers for 1950

At the anniversary meeting of the Royal Society held on November 30 the following were elected as officers and Council for the ensuing year: *President*, Sir Robert Robinson; *Treasurer*, Sir Thomas Merton; *Secretaries*, Sir Edward Salisbury and Sir David Brunt; *Foreign Secretary*, Prof. E. D. Adrian; *Other Members of Council*, Brigadier R. A. Bagnold, Prof. G. L. Brown, Prof. H. Davenport, Prof. F. G. Gregory, Sir Cyril Hinshelwood, Prof. R. P. Linstead, Prof. G. F. Marrian, Prof. H. S. W. Massey, Prof. F. E. Simon, Sir William Stanier, Sir George Thomson, Dr. H. G. Thornton, Prof. C. E. Tilley, Dr. F. M. R. Walshe, Dr. V. B. Wigglesworth, Prof. S. Zuckerman.

## British Glaciological Society: Officers for 1950

The following have been elected officers and members of committee for 1950 of the British Glaciological Society: *President*, G. Seligman; *Vice-President*, J. M. Wordie; *Honorary General Secretary*, A. H. Bolitho; *Honorary Treasurer*, T. H. Best; *Meetings Secretary*, D. S. Brock; *Members of Committee*, D. L. Champion, Miss J. Clarke, J. Hartog, Prof. S. E. Hollingworth, W. V. Lewis, Prof. G. Manley, Dr. N. A. Mackintosh, Dr. N. E. Odell, Dr. B. B. Roberts, Dr. K. Sandford, Prof. A. Stephenson and W. H. Ward.

## Announcements

The Manchester Federation of Scientific Societies' Christmas Lecture for Young People (thirteen to seventeen years of age) will be delivered by Prof. F. C. Williams at the University of Manchester at 3 p.m. on December 28 and 29. The lecture, which is entitled "Electrons in Control", will be illustrated by experiments.

The Royal Microscopical Society has established a cinemicrographic film library in order to make available films dealing with subjects which come within the range of the Society's activities. Hitherto, many excellent films, made in academic research institutions, have not been accessible for educational purposes. The collection, though at present not large, includes films by Comandon, Canti, Michel and Hughes. Further particulars, such as the fee for hiring these films, can be obtained from the Assistant Secretary, Royal Microscopical Society, B.M.A. House, Tavistock Square, London, W.C.1.

# GALACTOPOIETIC ACTIVITY OF PURIFIED ANTERIOR PITUITARY GROWTH HORMONE

By

P. M. COTES
Department of Biochemistry, University College, London

J. A. CRICHTON
Rowett Research Institute, Bucksburn, Aberdeenshire

DR. S. J. FOLLEY
National Institute for Research in Dairying, Shinfield, Nr. Reading

and

PROF. F. G. YOUNG, F.R.S.
Department of Biochemistry, University College, London

THE anterior pituitary factors concerned in the *initiation* of lactation are different from those capable of amplifying an existing milk flow (see reviews, refs. 1, 2), and Folley and Young[3] suggest that the term 'galactopoietic' be applied to an anterior pituitary substance which can augment established lactation irrespective of whether or not it can initiate the secretion of milk. Bergman and Turner[4] independently suggested the use of the words 'galactopoetic' or 'galactogogue' in a similar sense.

Asimov and Krouze[5] first showed that a single injection of a crude ox anterior pituitary extract can exert a substantial galactopoietic effect in milking cows. Folley and Young[3,6], estimating the galactopoietic potency of pituitary extracts by comparing the mean milk-yield of cows in declining lactation for two days before and two days after a single subcutaneous injection of anterior pituitary extract, obtained effects much greater than could be accounted for by the prolactin content of the extracts. We adopted the same procedure in the experiments reported here, and employed groups of cows the mean initial milk-yields of which varied between 26 and 42 lb./cow/day.

In a survey of the physiological activities of galactopoietic pituitary fractions, Folley and Young[6] observed a close association between the galactopoietic and 'anti-insulin' activities of different ox pituitary fractions, and later unpublished experiments have indicated that diabetogenic anterior-pituitary fractions are galactopoietic. Since Cotes, Reid and Young[7] have shown that purified growth hormone is highly diabetogenic in the intact cat (see also Milman and Russell[8]), we have examined this hormone for galactopoietic activity with and without the addition of possible pituitary synergists such as prolactin and adrenocorticotropin. The growth hormone employed was prepared at University College, London, from fresh ox anterior pituitary tissue by the method of Wilhelmi *et al* [9]. The adrenocorticotropin used in the experiment at Shinfield was made at Shinfield by Mr. J. A. F. Rook from ox pituitary glands by a method essentially that of Li *et al.*[10]; that employed in the experiment at Bucksburn was generously supplied by Armour and Co., Chicago; for the gift of the latter we are grateful to Dr. E. E. Hays and Dr. I. M. Bunding, of the Armour Laboratories. The prolactin was prepared at University College by Mr. M. Stack-Dunne from ox anterior pituitary tissue essentially by the method of Li *et al.*[11], its potency being about 30 I.U./mgm. The crude extract was prepared from fresh ox anterior pituitary tissue as described by Young[12].

The results, which are summarized in the accompanying table, show that growth hormone is highly galactopoietic. We have previously reported that 10 ml. of our crude ox anterior pituitary extract, 1 ml. of which is equivalent to 0·25 gm. of fresh ox anterior lobe tissue, gives an almost maximal

Influence of a single subcutaneous injection of anterior pituitary preparations on the milk yield of cows in declining lactation. *A*, the mean increase in milk yield for the two days after treatment expressed as percentage of the mean yield for the two days before treatment. *B*, net increase, that is, difference between *A* and the mean percentage increase of the corresponding saline-treated group. Standard errors follow the means.

| Treatment | Shinfield Farm | | | Craibstone Farm | | | Duthie Farm | | | Combined results for all farms | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | No. of cows | *A* | *B* | No. of cows | *A* | *B* | No. of cows | *A* | *B* | No. of cows | *A* | *B* |
| Saline | 4 | −0·50 ± 2·16 | | 4 | −3·16 ± 2·50 | | 4 | −3·52 ± 4·15 | | 12 | −1·89 ± 1·52 | |
| 15 mgm. growth hormone | | | | | | | 4 | 2·78 ± 4·15 | 6·30 ± 5·87 | 4 | 2·78 ± 4·15 | 6·30 ± 5·87 |
| 30 mgm. growth hormone | 4 | 6·49 ± 2·16* | 6·99 ± 3·05 | 4 | 6·36 ± 2·50* | 9·52 ± 3·53** | 4 | 5·51 ± 4·15 | 9·03 ± 5·87 | 12 | 6·31 ± 1·52** | 8·20 ± 2·15** |
| 60 mgm. growth hormone | | | | 4 | 2·94 ± 2·50 | 6·10 ± 3·53 | 4 | 4·76 ± 4·15 | 8·28 ± 5·87 | 8 | 3·42 ± 2·14 | 6·68 ± 3·03 |
| 5 ml. *FGS* | | | | 4 | 2·87 ± 2·50 | 6·03 ± 3·53 | | | | 4 | 2·87 ± 2·50 | 6·03 ± 3·53 |
| 10 ml. *FGS* | | | | 4 | 5·94 ± 2·50* | 9·10 ± 3·53** | 3 | 9·13 ± 4·89 | 12·65 ± 6·53 | 7 | 6·60 ± 2·22** | 9·90 ± 3·11** |
| 40 mgm. prolactin | | | | 4 | −2·34 ± 2·50 | 0·82 ± 3·53 | | | | 4 | −2·34 ± 2·50 | 0·82 ± 3·53 |
| 40 mgm. prolactin + 30 mgm. growth hormone | | | | 3 | 7·94 ± 2·94** | 11·10 ± 3·86** | | | | 3 | 7·94 ± 2·94** | 11·10 ± 3·86** |
| 7 mgm. *ACTH* | 4 | −7·44 ± 2·16** | −6·94 ± 3·05 | | | | 3 | −2·64 ± 4·73 | 0·88 ± 6·53 | 7 | −6·61 ± 1·96 | −5·54 ± 2·76 |
| 28 mgm. *ACTH* | | | | | | | 4 | −10·13 ± 4·15* | −6·61 ± 5·87 | 4 | −10·13 ± 4·15* | −6·61 ± 5·87 |
| 7 mgm. *ACTH* + 30 mgm. growth hormone | | | | | | | 3 | 4·28 ± 4·89 | 7·80 ± 6·53 | 3 | 4·28 ± 4·89 | 7·80 ± 6·53 |

*FGS* = Crude alkaline extract of ox anterior pituitary tissue; *ACTH* = adrenocorticotropic hormone. * Significant at 5 per cent level. ** Significant at 2 per cent level.

galactopoietic response[12] and contains 30–50 mgm. of growth hormone[7]. The results show that the galactopoietic activity of 30 mgm. of growth hormone is probably greater than that of 5 ml. of our crude ox anterior pituitary extract and little different from that of 10 ml. Thus, in these short-term experiments, the whole of the galactopoietic activity of the crude extract may well be accredited to the growth hormone it contains. No positive galactopoietic effect of prolactin or of adrenocorticotropin was observed with the doses we employed, nor was the simultaneous administration of these hormones with growth hormone found to influence significantly the galactopoietic activity of the latter (see table). In long-term experiments, involving repeated injections of crude extract (for example, over a period of three weeks[3,13]), pituitary thyrotropin might play a part, since the galactopoietic action of the thyroid hormone is well attested (see Bailey *et al.*[14]). In such experiments of longer duration, it is possible that the galactopoietic action of the crude extract might be greater than could be attributed to the growth hormone it contained; but this is a matter for further investigation.

The table shows that 60 mgm. of growth hormone has no greater galactopoietic effect than has 30 mgm., such an observation being in agreement with the previously observed almost maximal galactopoietic effect of 10 ml. of our crude extract[12]. Indeed, the effect of 60 mgm. of growth hormone is slightly smaller than that of 30 mgm. (though the difference is not statistically significant on the basis of our results), and if this possible difference is real we are at present unable to account for it.

The administration of 28 mgm. of adrenocorticotropin induced a significant depression of milk yield, and a similar tendency (statistically significant only at Shinfield) was also observed with a dose of 7 mgm. of this hormone. On the other hand, Dr. A. Roy, in earlier experiments in our laboratories, found that under some conditions adrenocorticotropin could exert a substantial galactopoietic action (see Young[3]). It is clear that the magnitude of the dose of adrenocorticotropin may be of critical importance in such experiments, and this possibility is under investigation.

We believe the galactopoietic action of growth hormone to be of physiological significance. Treatment with pituitary growth hormone may induce growth (H. M. Evans), the secretion of extra milk (present paper) or diabetes[7,8], according to the age, species and condition of the treated animal. The diabetogenic action of growth hormone can be regarded as "the pathological outcome of an excessive stimulation of those processes (depression of oxidation of carbohydrate with enhancement of protein storage and of fat combustion) which, under more physiological conditions, lead to such deposition of new tissue as is associated with growth" (Young[15]; see also refs. 8, 16). As was pointed out some years ago: "Growth, including fœtal growth, and milk production are processes requiring a special type of metabolic control, in that they both necessitate the preservation from oxidation of foodstuff that would otherwise, in an animal in equilibrium, be oxidized. . . . Since growth, galactopoiesis and diabetogenesis all involve a restraint on oxidative processes, it would not be surprising if there were some relationship between the hormonal mechanisms concerned with the control of these phenomena" (Young[3]). Our demonstration of the galactopoietic activity of growth hormone, already known to be diabetogenic under some conditions, satisfactorily conforms with the expected concinnity of physiological pattern.

We are indebted to Dr. D. P. Cuthbertson, director of the Rowett Research Institute, Aberdeenshire, for permission to use the herds at this Institute; to Mr. A. S. Foot for co-operation in making the cows at Shinfield available to us; and to Mr. C. P. Cox for assistance with the statistical analysis of the data. We also gratefully acknowledge the tenure of a Medical Research Council Training Studentship by P. M. Cotes, and the assistance given by the Medical Research Council towards the cost of this work by an expense grant to F. G. Young.

[1] Folley, S. J. (1945). In "Marshall's Physiology of Reproduction" (third edit., ed. A. S. Parkes), Chap. 20 (in the press).
[2] Young, F. G., *Brit. Med. Bull.*, **5**, 155 (1947).
[3] Folley, S. J., and Young, F. G., *J. Endocrinol.*, **2**, 226 (1940).
[4] Bergman, A. J., and Turner, C. W., *J. Dairy Sci.*, **23**, 1229 (1940).
[5] Asimov, G. J., and Krouze, N. K., *J. Dairy Sci.*, **20**, 289 (1937).
[6] Folley, S. J., and Young, F. G., *Proc. Roy. Soc.*, B, **126**, 45 (1938).
[7] Cotes, P. M., Reid, E., and Young, F. G., *Nature*, **164**, 209 (1949).
[8] Milman, A. E., and Russell, J. A., *Fed. Proc.*, **8**, 111 (1949).
[9] Wilhelmi, A. E., Fishman, J. B., and Russell, J. A., *J. Biol. Chem.* **176**, 735 (1948).
[10] Li, C. H., Evans, H. M., and Simpson, M. E., *J. Biol. Chem.*, **149**, 413 (1943).
[11] Li, C. H., Simpson, M. E., and Evans, H. M., *J. Biol. Chem.*, **146**, 627 (1942).
[12] Young, F. G., *Brit. Med. J.*, **2**, 897 (1941).
[13] Folley, S. J., and Young, F. G., *J. Endocrinol.*, **4**, 194 (1945).
[14] Bailey, G. L., Bartlett, S., and Folley, S. J., *Nature*, **163**, 800 (1949).
[15] Young, F. G., *Biochem. J.*, **30**, 515 (1945).
[16] Gaarenstroom, J. H., Hublé, J., and de Jongh, S. E., *J. Endocrinol.*, **6**, 71 (1949).

# RADIATION EFFECTS DUE TO PHOSPHORUS-32 IN FERTILIZER EXPERIMENTS

By R. SCOTT RUSSELL, S. N. ADAMS
AND
R. P. MARTIN
Department of Agriculture, University of Oxford

IT has been shown in water culture[1] that the rate of phosphorus absorption by plants is, under certain conditions, significantly reduced when activities of phosphorus-32 as low as 10 microcuries per litre are used as a tracer. Root-growth is also depressed; nevertheless, the development of the aerial parts of plants provides no consistent index of radiation damage. These effects are explained by the metabolic accumulation of labelled phosphorus, which may cause the root tips of rapidly absorbing plants to be exposed to radiation many hundred times more intense than that in the culture solution.

Effects resulting from the addition of labelled fertilizers to the soil are now being investigated. Plants are grown in pots containing 1,500 gm. soil, to which a constant level of potassium dihydrogen phosphate, labelled with varying activities of phosphorus-32, is added in solution. The full results will be described in due course in the *Journal of Experimental Botany*. This report is made since, despite the preliminary nature of the present results, they indicate that the seriousness of radiation damage in fertilizer experiments can be considerably greater than has frequently been supposed. The interpretation of radiation effects due to tracers in the soil is more complex than in water culture, since naturally-occurring soil phosphates are always present, and

Table 1. Effect of varying activities of phosphorus-32 on growth of barley. All treatments received the equivalent of 8 lb. total phosphorus/acre. Harvested 39 days after treatment

| Treatment: $\mu$ C. $P^{32}$/culture pot<br>$\mu$ C. $P^{32}$/gm. P | 0<br>0 | 0·16<br>18 | 0·8<br>92 | 4·0<br>460 | L.S.D. |
|---|---|---|---|---|---|
| Dry weight (gm./pot)<br>Shoots | 2·38 | 2·46 | 2·51 | 2·63 | — |
| Roots | 1·23 | 1·22 | 1·26 | 1·17 | — |
| Fertilizer phosphate absorbed (gm./pot) | | 3·42 | 2·75 | **2·45** | 0·79 (5%) |
| $\frac{\text{Fertilizer phosphate absorbed}}{\text{Soil phosphate absorbed}}$ % | | 16·74 | **12·4** | **7·9** | (see below) |
| $\log_e \frac{\text{Fertilizer phosphate absorbed}}{\text{Soil phosphate absorbed}}$ % | | 2·81 | **2·50** | **2·00** | 0·25 (5%)<br>0·37 (1%) |

Significant effects in heavy type. Capacity of culture pots, 1,500 gm. soil.

moreover the fertilizer phosphate is largely retained in the upper layers of soil even when it is added in dilute solution. The procedure here used resulted in 97–99 per cent of the fertilizer being retained in the upper two inches of soil. Between experiments, variations due to rainfall occur within these limits. If radiation from the tracer reduces the rate of nutrient absorption, it is apparent that this effect will occur mainly in the roots absorbing from the upper layers of soil. Roots absorbing soil phosphate in the lower horizons will be relatively unaffected. Thus radiation damage should result in an alteration in the proportion of fertilizer to soil phosphorus absorbed.

Table 1 shows the effects in spring-sown barley plants of the equivalent of 8 lb. phosphorus per acre, labelled with varying amounts of tracer. Four plants were grown per pot. Neither shoot- nor root-weight is significantly affected, though there is an upward trend in shoots. Phosphorus absorption is, however, depressed when 4 microcuries are applied per pot. When the fertilizer phosphate absorbed is expressed as a percentage of the soil phosphate absorbed, the effect is highly significant in the 4·0 microcuries per pot treatment, and in the 0·8 microcurie treatment it just attains the 5 per cent probability limit. On account of the magnitude of the differences between treatments, natural logarithms have been used for statistical analysis. It may be noted that levels of tracer above 4·0 microcuries have caused no significant increase in the observed effects.

It is apparent that the decay of phosphorus-32 during an experiment will lead to a progressive reduction in the level of radiation. Thus possible effects of recovery from radiation damage merit consideration, especially if the experimental plants remain in an active vegetative state for a considerable period, and if the supply of fertilizer phosphate is not limiting. Both these conditions were satisfied in an experiment on winter wheat grown under cool conditions. Results for a harvest 70 days after the application of fertilizer are given in Table 2. The tracer had then decayed to 3·4 per cent of its original activity. Dry weights again show no significant radiation effects, but the percentage of the absorbed phosphate which came from the fertilizer is increased. Roots show the effect to a markedly less degree than shoots, in which the effect is highly significant when 5 microcuries were added per pot. The suggestion that this is due to root regeneration in the upper layers of the soil is supported by counting the numbers of adventitious roots developed from the stem bases which did not penetrate more than 2 in. below the soil surface. Data on this point are insufficient to be of critical value.

In Table 3 the activities of phosphorus-32 used in a number of fertilizer investigations have been recalculated on the same basis as the present data. Differences not only in method of expressing results but also in the microcurie standard necessarily make these calculations approximate only. Furthermore, difficulties arise in comparing pot and field experiments, though there are reasons for believing that the radiation hazard is of the same order in both types of work[8]. It is none the less apparent that very varying activities of phosphorus-32 have been employed in fertilizer investigations, and that in some instances they have greatly exceeded the levels at which significant effects were observed in the present work. Since radiation damage is dependent on metabolic accumulation, considerable differences are to be expected between experiments. Thus the present results can provide no information applicable

Table 2. Effect of varying activities of phosphorus-32 on growth of winter wheat. All treatments received the equivalent of 49 lb. total phosphorus/acre. Harvested 70 days after treatment

| Treatment: $\mu$ C. $P^{32}$/culture pot<br>$\mu$ C. $P^{32}$/gm. P | 0<br>0 | 2<br>40 | 5<br>100 | 15<br>300 | 24*<br>480 | L.S.D. |
|---|---|---|---|---|---|---|
| Dry weight (gm./pot)<br>Shoots | 1·75 | 1·82 | 1·62 | 1·65 | 1·54 | — |
| Roots | 0·64 | 0·63 | 0·58 | 0·54 | 0·59 | — |
| $\frac{\text{Fertilizer phosphate absorbed}}{\text{Soil phosphate absorbed}}$ %<br>Shoots | — | 89 | 110 | 215 | 367 | (see below) |
| Roots | — | 100 | 97 | 115 | 123 | — |
| $\log_e \frac{\text{Fertilizer phosphate absorbed}}{\text{Soil phosphate absorbed}}$ % Shoots | — | 4·52 | **5·75** | **5·41** | | 0·13 (5%)<br>0·21 (1%) |
| Number of adventitious roots per pot which did not penetrate more than 2 in. below soil surface* | 8 | 10 | 15 | 21 | 23 | |

Significant effects in heavy type. * Excluded from statistical analyses on account of insufficient replication.

to other experimental conditions. It is apparent, however, that radiation effects can invalidate the results of fertilizer experiments when comparatively low activities of tracer are employed. Moreover, the absence of weight changes in shoots does not necessarily indicate that significant radiation effects have not occurred. Thus the assumption that radiation from the tracer has not invalidated experimental results can be fully justified only if it has been shown that the rates of absorption of fertilizer- and soil-phosphorus are unchanged when different activities of tracer are used to label a constant quantity of fertilizer phosphorus. No evidence on this question is contained in the papers cited in Table 3.

Table 3. Approximate levels of phosphorus-32 used in fertilizer studies

| | lb. P/acre | $\mu$ C. $P^{32}$ per gm. P | $\mu$ C. $P^{32}$ per pot (1,500 gm. soil) |
|---|---|---|---|
| Hendricks and Dean (ref. 2) | | — | 38–938 |
| Dean *et al.* (ref. 3) | 100 | 43–215 | — |
| Spinks and Barber (ref. 4) | 6·7 | 150–1,000 | — |
| Spinks and Barber (ref. 5) | 6·7 | 54 | 0·5 |
| Spinks *et al.* (ref. 6) | 6·7–60 | 33–1 600 | 0·9–14 |
| Dion *et al.* (ref. 7) | 5–21 | 26–260 | — |

Data converted from published results, assuming, where necessary, that $5{\cdot}5 \times 10^5$ counts/min. correspond to 1 microcurie.

Spinks and his co-workers[7] have recently given some consideration to radiation effects. Their conclusion, that radiation effects have not occurred in their experiments, is, however, based entirely on the assumed absence of weight changes in the shoots of plants treated with labelled phosphorus. It is to be noted that the greater part of the data is for plants treated with 26 microcuries of phosphorus-32 per gm. of total phosphorus, a considerably lower level than that usually used in their earlier work (see Table 3). Yet in one series of their results (7, Table *a*) plants treated with tracer showed significantly increased shoot-weights. They attribute this to uneven germination on one of their two experimental sites; but this can scarcely explain why, in both sites, the treatment which caused the greatest phosphorus absorption (namely, $NH_4H_2PO_4$, 48 lb./acre) showed the greatest increase in shoot-weight. There are some indications in the results of both the water culture investigations[1] and the present work that the absorption of radioactive phosphorus may, under certain conditions, result in increased shoot-weight. These trends are possibly explained by downward translocation being depressed on account of reduced root activity. It is not suggested that the data of Spinks and his associates can be interpreted only in this way. However, results which indicate this possibility are unconvincing as evidence that no radiation damage has occurred.

We acknowledge with thanks the generous financial aid of the Agricultural Research Council, which has enabled us to undertake this work. We are also much indebted to Prof. G. E. Blackman for his encouragement and suggestions during the course of the work.

[1] Russell, R. S., and Martin, R. P., *Nature*, **163**, 71 (1949).
[2] Hendricks, S. B., and Dean, L. A., *Soil Sci. Soc. Amer. Proc.*, **12**, 98 (1948).
[3] Dean, L. A., Nelson, W. L., MacKenzie, A. J., Armiger, W. H., and Hill, W. L., *Soil Sci. Soc. Amer. Proc.*, **12**, 107 (1948).
[4] Spinks, J. W. T., and Barber, S. A., *Sci. Agric.*, **27**, 145 (1947).
[5] Spinks, J. W. T., and Barber, S. A., *Sci. Agric.*, **28**, 79 (1948).
[6] Spinks, J. W. T., Dion, H. G., Reade, M., and Dehm, J. E., *Sci. Agric.*, **28**, 309 (1948).
[7] Dion, G., Bedford, C. F., St. Arnaud, R. J., and Spinks, J. W. T., *Nature*, **163**, 907 (1949).
[8] Russell, R. S., *J. Chem. Soc.* (in the press).

# MEETING OF BAVARIAN PHYSICISTS

THE first post-war meeting of Bavarian physicists, held in Munich during July 29–August 2, was attended by almost all noted physicists of the western zones of Germany and even by one representative of the eastern sector of Berlin.. It was a happy occasion, connected with a series of celebrations in honour of the sixtieth birthday of Walther Gerlach, who has recently been re-elected *Rector Magnificus* of the University of Munich. Gerlach's gay spirit indirectly enlivened all activities, and the dull solemnity of the usual congress dinners was expelled by a cabaret staged by his pupils.

Of more than forty scientific addresses, the following aroused the greatest interest, the order being that in which they were delivered. E. Smits and W. Gentner (Freiburg im Breisgau) described their determination of the argon content in sylvine (potassium chloride) of different ages—200 to $35 \times 10^6$ years old. They found, in agreement with Aldrich and Nier (*Phys. Rev.*, 1948), a ratio of $K$-capture to beta-radioactivity of 5–10 per cent. R. Fleischmann (Hamburg) presented a procedure for measuring the *absolute* phase difference in the reflexion of light. He has succeeded in determining the refractive index and the absorption coefficient in a manner different from, and simpler than, that of Drude. A. Kochendoerfer (Stuttgart) stated that Mott and Nabarro's theory describes a kind of hardening which is different from that with which he is concerned; in his work the hardening occurs alone when pure crystals are sheared and hence must be due to the gliding as such. M. Schuler (Göttingen) has observed that clock pendulums made of invar may change their length spontaneously, becoming either shorter or longer.

When intense X-ray flashes of $10^{-7}$ sec. duration are shot through electric sparks in liquids, in a direction parallel to the spark path, it has been found by W. Schaaffs (Berlin-Siemensstadt) that short sound-wave pulses with a velocity of 10,000 m. per sec. are emitted, and matter is compressed to three times its normal density. K. H. Hellwege (Göttingen) has carried on Bethe's work with special application to the bi-axial crystals of the rare earths. H. A. Bomke (Munich) described how, by combining a micro-ionization chamber with an extremely sensitive amplifier arrangement, he can determine local deviations in a three-dimensional radium or X-ray field; this is of medical importance. W. Groth (Hamburg) has found new possibilities for the separation of isotopes by diffusion in the gas phase. H. Auer (Munich) discussed some physical problems of age hardening in aluminium–copper alloys. E. Kappler (Münster) defined a physical scale of hardness; starting from Hertz's elastic formulæ, he developed a theory of plasticity.

Ferromagnetic remanence in normal polycrystalline materials was dealt with by Walter Gerlach. An *inner* demagnetizing factor is found experimentally to rise near the Curie point, indicating that the ferromagnetism of different domains within one specimen disappears at different temperatures. The result is that the true remanence remains constant at about half saturation over a large range of temperatures and vanishes gradually immediately below the Curie point. The coercive force has a sharp maximum at the same temperature. H. Schroeder (Munich)

gave an account of his use of multilayers for very varied purposes, such as the production of anti-reflexion, selective mirrors (for example, separating light and heat rays), polarization and monochromatic filters. P. Grassmann (Frankfurt) has constructed a small apparatus for liquefying air. H. Vatter (Geislingen) described how to solder metal to ceramic so as to obtain high-vacuum containers for industrial use. F. Foerster (Eningen) dealt with a further development of the magnetic and eddy current methods for testing matter without damaging it.

A section on superconductivity was introduced by M. von Laue (Göttingen). He expounded a new theory which preserves all the good points of the former phenomenological theory, but avoids a difficulty which has arisen from the quantum theoretical (Heisenberg) assumption of a maximum density for the super current. The new theory achieves this improvement by replacing the relation between current density and super impulse, which was hitherto linear, by a more general relation.

GABRIELE RABEL

## OIL-FIELDS OF NORTH-WEST GERMANY

A STRUCTURAL map of 20,000 square kilometres of north-west Germany has been on view in the new building of the Department of Geology and Mineralogy at Oxford as part of the exhibition of oilfield development held there to commemorate the opening of the building by the Vice-Chancellor on July 7 and the subsequent meeting of the Empire Mining and Metallurgical Congress. This map represents the greatest single contribution to tectonic geology to be published since the appearance of the tectonic map of the United States produced by the American Association of Petroleum Geologists under the guidance of the U.S. Geological Survey.

The map and explanatory handbook[1] form part of the results of the team-work carried out under the leadership of Major A. E. Gunther (a graduate of the Oxford Geology School), who was in charge of the Government's oil-fields investigations in the British Zone of Germany in the two years after the end of the War. Accompanying this map there are in addition eight volumes of B.I.O.S. Reports (Nos. 1010–1017, British Oilfields Investigations[2]) covering every aspect of the development of the German crude oil industry from exploration to the technical and industrial structure of the industry.

As all who visited the exhibition at Oxford can testify, the map is a great achievement due to the co-operation of scientific and technical effort, which would not have been possible but for the close integration of academic and scientific with practical and industrial talent. It reflects the highest credit on the geologists of the German Geological Survey who have compiled the constituent sheets from a varied mass of data, and on their chief editor, Dr. Alfred Bentz; but above all on Major Gunther, who initiated the project and not only carried it through in most difficult circumstances but also so successfully overcame the political and other obstacles of the times that he receives in the introduction a high tribute from the German editor.

The exceptional scientific interest of the area was apparent to all in 1922 through the publication of Prof. H. Stille's pioneer "Übersichtskarte der Saxonischen Gebirgsbildung" on the scale of 1 : 250,000. At that time there were only four oil-fields in north-west Germany, two of which had been producing since the nineteenth century. The drive for German self-sufficiency in the 1930's led to great activity, which was, of course, intensified during the War. Between 1934 and 1945 the State covered the whole of north-west Germany with geophysical surveys and caused the drilling of some nine hundred subsidized exploration wells. In consequence, twenty-five new oil-fields were discovered and production was increased from 300,000 tons a year in 1933 to 1,000,000 tons in 1940. This achievement is attributed largely to the institution in 1939 of a central authority to plan and carry through the work as a whole. The authority was at first the Reichstelle, which after 1941 became the present Reichsamt für Bodenforschung—the lineal descendant, but with greatly increased powers and scope, of the pre-war Preussische Geologische Landesanstalt, the scientific publications of which over many years earned it world-wide respect. After 1934 all crude oil was State property, and drilling was not only subsidized but also so directed as to ensure that the best technical methods were employed and that individual concessions were related to structures.

It is the scientific results of this great programme of exploration and exploitation that are gathered together and presented in co-ordinated form in the present map. For ten years the area was subjected to detailed and repeated geological and geophysical survey, by every available method, and to shallow and deep drilling. Some two hundred and fifty geological structures were revealed, of which about two hundred are salt domes. The map shows the oil structures at whatever depth they may lie, stripped of all obscuring strata, whether Quaternary, Tertiary or Cretaceous.

The work was initiated in August 1945 and completed a year later; but shortage of paper and difficulties of printing have caused delay. Some will see in it a value which transcends even its scientific achievement; for it is an inspiring example of international scientific and industrial collaboration which has overcome exceptional political and material obstacles to the attainment of a high scientific purpose.

W. J. ARKELL

[1] Erläuterungen zur Geotektonischen Karte von Nordwestdeutschland. 1 : 100,000. Herausgegeben von A. Bentz. Pp. 235. (Celle: Reichsamt für Bodenforschung, 1949.)
Geotectonic Compilation Map of North-west Germany. Scale 1 : 100,000 in 26 sheets with volume of explanation. Pp. 235. Issued by Reichsamt für Bodenforschung, Celle. (London: H.M. Stationery Office, 1949.)

[2] Oil Fields Investigation, B.I.O.S. Final Reports, Item No. 30. Nos. 1010–1017 inclusive. (London: H.M. Stationery Office.)

## THE ELECTRICAL ENGINEER AND THE COMMUNITY

THE presidential address of Prof. E. B. Moullin to the Institution of Electrical Engineers dealt in broad principle with the position of the professional electrical engineer in the community, the nature of his qualification and the proper exercise of his function. In particular, the place of the Institution in relation to the profession was considered.

"Societies," said Prof. Moullin, "which are founded upon and which exact professional qualifications are a device for compromising rationally between unrestricted personal liberty and unrestricted compulsion, and thus are an important factor in

maintaining a state of civilization. Viewed in this light they are seen to have a considerable degree of international status. Institutions of the same profession in different countries bear some resemblance to the local branches of a Universal Church, and the same is true of universities." There is, he suggested, a need for vigilance lest, in the modern State, the over-development of central administration should debase the true professional engineer into a mere specialist adviser to administrative boards.

Referring to the profession of electrical engineering, Prof. Moullin said: "A profession can be great without necessarily being learned. But we are essentially a learned profession, because the possibility of there being an electrical engineering profession depends, for its beginnings, on the highly intellectual and learned concepts of electricity. You cannot conceive of the Law as being anything but a learned profession because it depends, for its beginnings, on highly intellectual concepts. But there are other very great professions, possibly Medicine, where beginnings did not have to wait for the relevant purely intellectual concepts." The maintenance of standards of individual professional competence, he said, imposes upon the Institution an obligation to formulate a broad educational policy, although the Institution is not, in the conventional sense, an educational body. The essentially professional part of the electrical engineer's training is based on the industry, and "the distinction between those who have started at the university and those who have not done so" but have received their academic studies at a technical college, possibly on a part-time basis, "commonly becomes progressively more blurred as the years go on". The Council of the Institution does not favour a contemporary proposal to set up new technical colleges in which full-time undergraduate teaching in specialized branches of engineering would be carried on. "It is inevitable that engineers should be prominent in the affairs of man, in this era, and it is important to the welfare of contemporary civilization that those who are prominent should have had a broad education; this is obtainable in the university but is much less available in a monotechnic college. Recognizing the influence which engineers must have in the community, the Council are glad that a large number of those who enter our profession have been exposed to the good influences of a university during their student days." There is, in this connexion, a certain amount of misunderstanding in regard to the number of professional electrical engineers required by the industry of Great Britain. It is estimated that to meet the long-term demand an increase of only about ten per cent in the number of men qualifying annually is required. The present real shortage is in the number of trained technicians.

Prof. Moullin then referred to a recent decision of the Council of the Institution to foster and indeed to sponsor the setting up throughout Great Britain of a system of postgraduate courses of study in which leading exponents in the profession would make their specialized knowledge available to the general body of the engineering community. The physical framework of technical education in Britain is particularly favourable to this development, having, as we do, a large number of local educational centres in which such courses could be provided.

Prof. Moullin was somewhat sceptical as to the value of research training in the universities for young men who have just graduated, and he expressed a preference for the practice of bringing promising research men back into the university from industry at a later stage.

Examining in some detail the relation of the Institution to the profession, Prof. Moullin explained the practical significance of the charter and by-laws and discussed the constitution of the Council, the representation of the local centres and the constitution of the specialized Sections. "Because the Institution has existed for fewer years than our two great cousins, we are truthfully called the youngest of the three: but that statement can be misleading. It is only about 120 years since ideas and apparatus emerged to a point where Ohm's law could be recognized, and only 108 years since Ohm was awarded the Copley Medal in commemoration of the discovery of his law, a discovery which brought technical application a whole range nearer. Without sensible error, we may call this the centenary of the birth of electrical engineering proper; and it is the 78th year of the Institution, which has therefore guided the development of the art for three-quarters of the time the art has existed." J. G.

---

# THE JOHN INNES HORTICULTURAL INSTITUTION

## ANNUAL REPORT

THE annual report of the John Innes Horticultural Institution always succeeds in giving a large volume of results in relatively small space. That for 1948 (from the Institution, Bayfordbury, Herts; May 1949) is no exception. It will perhaps be remembered that the Institution recommended the raising of controlled hybrid raspberries, which would be free from virus diseases which are not seed-borne. D. Lewis and P. R. Day now review the results of five years of work on this question. They conclude that the hybrids are established more quickly than clonal stocks, yielding more in the first two years. Thereafter, virus infection takes place, when a virus-free clone of Norfolk Giant yields more than the hybrids. Seed of a new bush variety of tomato, named 'Puck', has been produced and released by M. B. Crane and A. G. Brown. It is early-maturing and heavy-cropping, but further breeding work is in progress. Genetic studies on pears have also been continued by M. B. Crane and D. Lewis; the present report includes a brief analysis of the inheritance of fruit and vegetative characters.

The Genetics Department, under K. Mather, was concerned mainly with the organisation, properties and analysis of the polygenic systems which control quantitative or continuous variation. It now seems clear that there can exist within a single species genetic differences sufficient, when selected, to produce diversity as great as that between different species. Various systems of genetic isolation have been studied; in *Petunia*, for example, the too-unlike pollen is disfavoured as well as the too-like. In *Antirrhinum*, genetic isolation of some species depends on the pollen-style relation; but between *A. majus* and *A. glutinosum* it depends on insect behaviour. A. J. Bateman, studying the French bean, has also found somewhat comparable behaviour. This plant is normally inbred; but some varieties show a small percentage of out-crosses.

The director of the Institution, Dr. C. D. Darlington, reports work from the Cytology Department on differentiation in the pollen grain and the occurrence

of iso-chromosomes. An interesting explanation of unequal distribution of cytoplasm when the generative nucleus is formed lies in the eccentric position of the primary nucleus before division. At mitosis, one of the daughter nuclei is therefore nearer the cell wall than the other, a difference in position which is accentuated by the infiltration of ribose nucleic acid into the zone between the two nuclei. Harlan Lewis, a visitor from the United States, shows some interesting similarity in range of chromosome numbers between *Clarkia* and *Godetia*. Cytology of *Narcissus* varieties is reported by Miss A. P. Wylie. The ancestral species *N. pseudonarcissus* and *N. poeticus* are diploid ($2n = 14$). Triploid varieties, raised about 1860, include Emperor, Empress and Sir Watkin. The variety King Alfred was one of the first tetraploids.

In the Garden Department, W. J. C. Lawrence again demonstrates the beneficial effects of twenty days of artificial illumination of tomato seedlings, showing increases of subsequent fruit yield, particularly in the early pickings, and average 10–16 per cent increase over the whole fruiting season. Other investigations include the use of 'standardized' loam, the best methods of raising particular plants, and the use of soil blocks instead of pots for growing plants.

A review of such a concentrated annual report must of necessity be somewhat invidious. There is a good deal of information for the teacher, the advisor and the research worker; such persons must, however, be referred to the report itself, or to the numerous specialist papers cited therein.

## INTERNATIONAL CONFERENCE ON SCIENCE ABSTRACTING

AN International Conference on Science Abstracting, arranged by the United Nations Educational, Scientific and Cultural Organisation, was held during June 20–25, 1949, at Paris, and the Final Act has now been made available (Paris: Unesco House, 19 rue Kleber).

This Final Act was inspired by the conviction of the important place of abstracting and indexing services in scientific communication and of the inadequacies of the present overall arrangements. The Conference regarded the objectives of abstracting in science as complete coverage by abstracts of all papers containing new information, and adequate access to abstracts for all men of science in all countries. To this end, in the Final Act a number of specific recommendations are detailed. These include, besides the continuance of Unesco's efforts to promote the free interchange of scientific literature among different countries, the extension of abstracting and indexing services to cover such fields as agriculture and applied biology, which are not at present covered. Abstracting services are also recommended to provide separate sections for information on new scientific and technical apparatus and equipment, where this is not already done. Publication of abstracts, particularly agricultural abstracts, in additional languages is also urged, and abstracting agencies are recommended to co-operate by extending agreements for the exchange of abstracts and of original material for abstracting, and by defining their respective subject fields. The Conference noted that the Abstracting Services Consultative Committee, serving the interests of the United Kingdom and of the British Commonwealth and embracing the whole field of science, had recently been established in London, and that the Unesco Co-ordinating Committee on the Abstracting and Indexing of Medical and Biological Sciences had been constituted on a permanent basis. The Conference recommended similar action in other regions and for other subjects, suggesting that regional or national committees on a voluntary basis should be formed to ensure that scientific publications in their own region are adequately listed and abstracted, and that scientific workers in their region are supplied with abstracts of papers published in foreign countries.

The formation of subject committees at an international level to co-ordinate abstracting in the major fields of pure and applied science is also suggested; and in particular it is recommended that Unesco should invite the appropriate bodies to co-operate in establishing subject committees of users and publishers of abstracts of physics and engineering, pure and applied chemistry, agriculture and applied biology, and should offer these committees facilities similar to those already provided for the Co-ordinating Committee on the Abstracting and Indexing of Medical and Biological Sciences. The Conference also endorsed a proposal for the publication under international auspices of a general abstracting periodical for physics, pure and applied, including astrophysics and the geophysical sciences, and possibly branches of engineering, and recommended the formation of a committee for this purpose. Other recommendations were in line with those of the Royal Society's Scientific Information Conference last year and relate to such details as the provision of synopses (the "Guide for the Preparation of Synopses" issued by the Royal Society being suggested as a basis for discussion), titles and the presentation of abstracts, lists of periodicals abstracted and of references and tables of contents, as well as to terminology and nomenclature. Publication, at least every five years, of a directory of indexing and abstracting services is recommended, as well as the establishment of regional bibliographical centres and depositories for published and unpublished works. Finally, the Conference urged support of the development of a standardized classification, and also the need for detailed evaluation of the various systems proposed for chemical notation, in view of their value for recording chemical data and possible application in indexing; and also the convening of a small conference of experts to lay the foundation for an international code for use with mechanical or electrical devices for selecting documents.

To the general importance of most of these matters most scientific workers would subscribe, and in Great Britain a committee has already been set up, under the chairmanship of Dr. C. W. M. Findlay, to consider problems of abstracting in the light of the discussions at the Royal Society's Scientific Information Conference last year. The "Guide for the Preparation of Synopses" was prepared by this Abstracting Services Consultative Committee. Not all these matters mentioned, however, are of the same urgency or importance, and financial considerations may well dictate that in the first instance attention be concentrated on only a few of them. The Unesco Abstracting Conference itself recognized that the provision of financial means would require special consideration, and suggested that on this point also Unesco should consult the World Health Organisation and the Food and Agriculture Organisation.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## The Scintillation of Stars

It is usual to advance a physical explanation of the scintillation of stars. Thus Wood[1] suggests that gradations in the refractive index of the atmosphere give rise to striæ. The gradations are said to be due to hot and cold currents which act as convex and concave cylindrical lenses. Wood also thinks that the disappearance of the effect when a given star is viewed through a telescope is due to the objective collecting several such striæ (which are 3–4 cm. apart), the average illumination being constant. Recently, however, a physiological explanation has been advanced (Hartridge[2]); both change of brightness and colour are ascribed to the slight movement of the star image over the retina and also to local variations in the retinal receptors, which will be more sensitive in some parts and less so in others; where red receptors abound there will be a bias in favour of red, whereas other regions will be more favourable to green, for example. It seems likely that Holmgren[3] was the first to observe variations in hue in a local source of light. He found that a monochromatic yellow light was sometimes seen red, sometimes green, and sometimes colourless. Blue was found to appear green, blue, violet or colourless.

Some recent experiments appear to be in favour of this hypothesis. Naked electric light bulbs seen at a distance of several miles on a dark night were seen to be twinkling very obviously. On examining them through a telescope which magnified about eight times, no twinkling was observable. Other lamps, much closer to the observer, did not appear to twinkle when looked at with the naked eye, but began to do so as soon as they were examined through the telescope the reverse way round. The conclusion to be drawn from this experiment is that bright lights do not twinkle but dim ones do (*vide infra*). It was found, however, that very dim lights do not twinkle in the normal manner: they may show slight variations in intensity but not in hue.

These experiments have been repeated with a local source consisting of a small 2·5-volt electric-light bulb, situated about two metres from the observer. This was reduced in apparent size by means of a microstimulator, which consists of a lens system reducing the visual angle subtended by objects at the eye about twenty-five times. When using this arrangement in a dark room, the observer saw a black background with a very small bright point of light which showed no signs of scintillation. If a neutral filter of at least 1·0 density is now interposed, scintillations become visible. However, on reducing the brightness of the image still further by using a filter of greater density, the scintillations stop again. The optimum intensity at which scintillations are seen was not found to be critical, but why is there an optimum at all? This indoor experiment leads to the belief that scintillations of stars do not depend solely on atmospheric currents: in fact, the existence of the scintillation of a small source of light in the laboratory suggests that the atmosphere takes a secondary role in the observed effect.

While movement of the image facilitates the observation of the effects described above, it is not essential. Thus, in the instance of stars, the image may appear to move owing to alterations in the refractive index of the atmosphere: hence different receptor regions will be stimulated in turn. In the laboratory experiment, however, there is no question of any movement of the source; it is to be concluded that, when the eye is not examining a detailed pattern subtending a considerable angle, it performs minute movements which give rise to the above effects.

The physiological explanation referred to above is as follows: the retinal image of any point source consists of an Airy diffraction pattern, that is, of a bright dot surrounded by a number of bright and dark rings, which grow less intense as one proceeds away from the centre of the pattern towards its edges. The dimensions of this pattern with eye pupils of 3–5 mm. diameter are such that a large number of retinal receptors could receive stimulation. With a bright pattern a large number of receptors are stimulated adequately and, in consequence, the source looks large; when, on the contrary, the pattern is dim, only a few receptors are adequately stimulated, and hence the source looks small. Thus a telescope which appears to magnify the image does not really do so, but merely increases the brightness of the retinal image and consequently causes it to appear larger; *vice versa*, a microstimulator which apparently reduces the dimensions of the source under examination does not, in fact, do so; but by reducing the quantity of light entering the eye it causes the diffraction pattern to appear smaller. When the pattern appears large, a considerable part of the retina receives sufficient stimulation, and therefore local variations in retinal sensitivity are averaged out. Because of this very bright stars do not scintillate. When, however, the pattern appears to be extremely small, the quantity of light is insufficient to act as a stimulus for the cone receptors, and the eyeball is therefore rotated so as to bring the image on to a part of the retina which contains rods. Movements of the image over this part of the retina will not produce variations in colour because the rods are not colour- but only brightness-receptors. Neither will they produce changes in brightness, because the rods do not vary appreciably from one another in sensitivity. When, however, the brightness of the diffraction pattern is of intermediate value, and is such that it stimulates a few cones, then, as the position of the image on the retina varies, it falls now on one variety of receptor and now on another, thus causing apparent fluctuations of both brightness and colour. In further support of the view that it is cone and not rod vision which is required, it seems apposite to quote from Tousey and Hulburt's recent paper[4] on the visibility of stars: "... in general, twinkling seemed more prominent in the day than at night". Moreover, the presence of scotomata in the fovea should also be borne in mind.

A physical explanation which readily suggests itself, especially in the light of Pirenne's work[5], is that quantum fluctuations are responsible for the change in brightness. On that basis, however, it is extremely difficult to account for the changes in hue so easily observed; and it is impossible to explain the fact that sufficient magnification causes the disappearance of the scintillations. Wood's explanation, on the other hand, covers the latter point, but is equally weak when the question of changes in hue is faced. It is also difficult to see on either of these theories why striæ should have a more marked effect during the day than at night. While the purely

physiological explanation of the scintillation of stars appears to account for all the observed facts, it does not rule out the possibility that in certain circumstances physical variations may also occur. These, however, are not likely to be present with purely local sources such as those used in our experiments.

H. HARTRIDGE
R. WEALE

Vision Research Unit,
Institute of Ophthalmology,
Judd Street, London, W.C.1.
Aug. 2.

[1] Wood, "Physical Optics", 3rd ed., p. 91 (New York: The Macmillan Company).
[2] Hartridge, *Phil. Trans. Roy. Soc.*, B, **232**, 618 (1947).
[3] Holmgren, Cong. période internat. and sci. méd. C.R. Copenhagen, 1, 93 (1884).
[4] Tousey and Hulburt, *J. Opt. Soc. Amer.*, **38**, 891 (1948).
[5] Pirenne, *Proc. Camb. Phil. Soc.*, **42**, 78 (1946).

## Inelastic Scattering of Deuterons

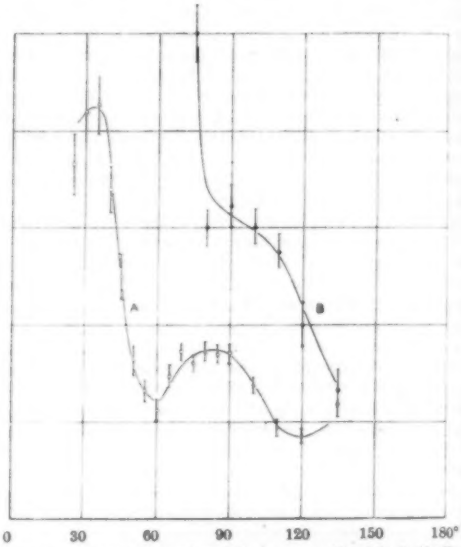
IN a recent communication, Greenlees, Kempton and Rhoderick[1] report observations which indicate that deuterons may be inelastically scattered by nuclei of magnesium and aluminium. We have independently reached a similar conclusion as a result of experiments in which a homogeneous beam of 7·5-MeV. deuterons from the Liverpool cyclotron were the bombarding particles.

In our apparatus the particles emitted from the target at angles within the range 25–145°, measured from the direction of the incident beam of deuterons, can be detected by means of a differential ionization chamber. Protons and deuterons near the end of their range give rise to pulses in this chamber which are different in size. By adjusting the biasing voltage of the pulse amplitude discriminator, it is possible to tell which peaks in the range spectrum of the particles are due to protons and which to deuterons. For example, an increase in the biasing voltage sufficient to reduce the height of a deuteron peak to one-half will reduce the height of a proton peak to one-thirtieth.

In this way, we were able to show that two prominent peaks in the spectrum from aluminium and one in that from magnesium are due to deuterons of smaller energy than that of the elastically scattered deuterons. As a check on this conclusion, we measured the decrease in the range of these groups of particles when the energy of the incident beam was decreased by a known amount. The decrease would be greater for a proton group than for a deuteron group of the same range. The measured decreases were, in fact, consistent with the particles being deuterons.

The energies of the nuclei excited in the inelastic scattering processes have been calculated from the range of the particles scattered elastically and inelastically. The excitation energies are found to be $0{\cdot}99 \pm 0{\cdot}05$ and $2{\cdot}17 \pm 0{\cdot}05$ MeV. in the case of aluminium, and $1{\cdot}36 \pm 0{\cdot}05$ MeV. in the case of magnesium. These figures are consistent with the values obtained by the workers at Cambridge. The deuteron peak corresponding to the 0·99-MeV. level in aluminium has a width greater by about 50 per cent than that of the 2·17-MeV. level. This probably indicates the excitation of more than one level at an energy of about 1 MeV. in the aluminium nucleus, in agreement with observations by Rhoderick[2] on the inelastic scattering of protons.

The formulation of a theory of the inelastic scattering process of deuterons will be aided by a knowledge of the way in which the nuclear cross-section for this process changes with the angle of scattering. Accordingly, we have measured the intensity of the groups of inelastically scattered deuterons from aluminium and magnesium in the range of scattering angles from 25° to 135°. The results for magnesium are displayed on curve *A* in the diagram. The vertical scale is proportional to the number of inelastically scattered deuterons leaving the target within a fixed solid angle; the mean angle of scattering is measured in the laboratory system. At each angle the counter accepts particles emitted within 3° around the mean value; the angular divergence of the incident beam itself is negligibly small. Curve *B* in the diagram shows, in the same way, the variation in the intensity of the elastically scattered deuterons from magnesium, the vertical scale being the same as for curve *A*.



Angular variation of intensity of deuterons scattered inelastically (curve *A*) and elastically (curve *B*) from magnesium

We have also made a search for deuterons inelastically scattered from targets of carbon, nickel and gold. With carbon no groups of such particles could be detected below an excitation energy of 1·9 MeV. A group having an intensity greater than 2 per cent of that of the elastically scattered deuterons at a scattering angle of 90° could have been detected. In the case of gold, no group having intensity greater than 0·5 per cent of that of the elastic peak at a scattering angle of 90° could be detected for excitation energy less than 2·9 MeV. The spectrum of the range of particles from the nickel target at 90° shows a small deuteron peak having an intensity about 2 per cent of that of the elastically scattered group. The corresponding excitation energy is $0{\cdot}82 \pm 0{\cdot}05$ MeV.

J. R. HOLT
C. T. YOUNG

George Holt Physics Laboratories,
University of Liverpool.
Oct. 24.

[1] Greenlees, G. W., Kempton, A. E., and Rhoderick, E. H., *Nature*, **164**, 663 (1949).
[2] Rhoderick, E. H., *Nature*, **163**, 848 (1949).

## Use of *Bremsstrahlung* in Making Rapid Assays of Millicurie Amounts of Phosphorus-32

CONVENTIONAL methods of beta-ray measurement for checking the activity of a pure beta-emitter such as phosphorus-32, in therapeutic amounts, have the following disadvantages: (1) The container must be opened, and the sterility of the solutions sent out in sealed ampoules (from Harwell) or in sealed screw-cap bottles (from the Atomic Energy Commission, U.S.A.) is thus interfered with. (2) Careful aliquots and high dilutions must be made, or careful evaporation procedures must be followed. In any event some handling of potentially dangerous material is involved. (3) These rather tedious procedures must be repeated if carrier-free material is to be subdivided. The activity of the subdivided amounts should be checked, as it is not possible to predict the loss by adsorption on the walls of the original container.

We have found that these difficulties can be avoided by using a high-pressure ionization chamber to measure the *Bremsstrahlung* from therapeutic quantities of phosphorus-32, two millicuries being easily measurable by this means. Measurements are made with the radiation striking the base of the chamber, which is of steel 2·3 cm. thick. The *Bremsstrahlung* is compared with a radium standard (usually 7·81 μgm. as standardized by the Radiochemical Centre). On three successive batches of phosphorus-32 the following results were obtained for radium equivalence per Harwell millicurie: (1) 0·68 μgm.; (2) 0·73 μgm.; (3) 0·71 μgm.

These results fall within the 10–15 per cent error allowed for[1] in supplying quantities of phosphorus-32 of the order used (10 mc.).

As the radiation passes through almost an inch of steel, the measurements are independent of variations in the thickness of the phosphorus-32 container, and it is possible to work at distances from the chamber sufficient to make variations in the volume of the solution or the dimensions of the container unimportant.

We are indebted to Dr. L. H. Gray for a drawing of the pressure chamber he designed. This note is published with the permission of the South African Council for Scientific and Industrial Research.

T. KVAH ALPER
LORENE DU PREEZ

National Physical Laboratory,
South African Council for
Scientific and Industrial Research,
Pretoria, South Africa.
Oct. 22.

[1] Harwell List of Radioactive Isotopes, §6.

## A Short-lived Metastable State in Titanium-46

Benedetti and McGowan[1], Mandeville and Scherb[2] and Hirzel, Stoll and Wäffler[3] have attempted to detect short-lived metastable states of radioactive nuclei by using the method of delayed β-β and β-γ coincidences. Several decay periods have been detected by these methods. We have examined delayed γ–γ coincidences using a method similar to that used by Bunyan *et al.*[4], but with two counting channels instead of one. The delay of one of the channels is kept fixed and is called the fixed channel. The γ-counters were kept symmetrically

Fig. 1. Scale ½ size

with respect to the source and had sufficient thickness of matter to cut down all β-rays below 1·7 MeV. The γ-counters, 3 cm. long and 2 cm. in diameter, were filled with a standard argon and petroleum ether mixture at a pressure of 14 cm. of mercury. The counters had a plateau of 200 volts and the starting potential was 850 volts. Delayed γ-γ coincidences were observed with a source of scandium oxide irradiated with neutrons arranged as in Fig. 1 with respect to the two γ-counters.

The electronic circuits consist of two multivibrators and two other multivibrators feeding into the coincidence stage. One channel has a fixed delay of about 0·3 microsec. and the other a variable delay of 0·5 microsec. to about 22 microsec. The random coincidences as well as the electronic resolving times were measured independently. Both methods gave a resolving time of the order of 0·5 microsec. The curves for coincidences per minute against the delay in the multivibrator delay-channel in microseconds has been plotted for both cobalt-60 and scandium-46 (Fig. 2). Cobalt-60 is known to have two coincident γ-rays without any delay, and is thus a convenient source for calibrating the counters and the electronic circuits. The delay curve obtained for cobalt-60 is due to the normal pulse distribution in the counters and follows a Gaussian error distribution. The half-

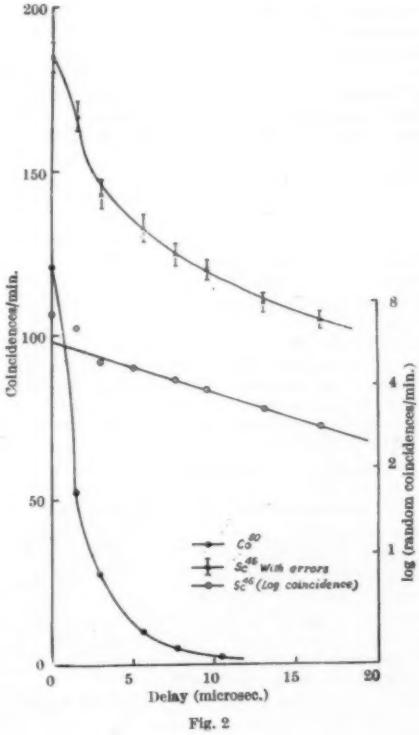



Fig. 2

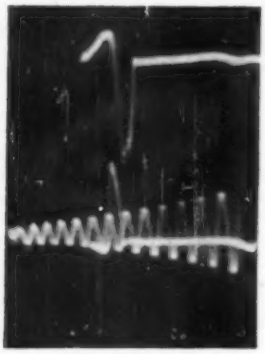


Fig. 3

width and the height of this distribution was dependent on the geometric size and the gas pressures inside the counters. In Fig. 2 is also plotted the logarithm of the coincidence-rate after deducting the random counts against the delay to obtain the half-life of the metastable state of titanium.

The delay time was calibrated in microseconds by feeding the same pulse into both channels, and the output of the two channels was fed to a double-beam oscilloscope (Cossor), the specially constructed hard-valve time-base of which included a damped marker oscillator triggered by the initial pulse. The marker oscillator frequency was measured with a communications receiver. Fig. 3 is a photograph of the two pulses and marker oscillations. The half-life of the metastable state of titanium-46 is found to be $13{\cdot}2 \pm 0{\cdot}8$ μsec.

The normal distribution of the counter pulses has not been taken into account in the present determination of half-life and this may tend to decrease the value obtained above. This point, among others, is being investigated, and a fuller report will be published in the *Indian Journal of Physics*.

Our thanks are due to the director, Prof. M. N. Saha, and the staff of the Institute of Nuclear Physics, Calcutta.

B. D. Nag
Sunil Sen
Santimay Chatterjee

Institute of Nuclear Physics,
University of Calcutta,
92 Upper Circular Road,
Calcutta.
July 12.

[1] De Benedetti, S., and McGowan, F. K., *Phys. Rev.*, **74**, 728 (1948).
[2] Mandeville, C. E., and Scherb, M. V., *Phys. Rev.*, **73**, 634 (1948).
[3] Hirzel, O., Stoll, P., and Wäffler, H., *Helv. Phys. Acta*, **20**, 241 (1947).
[4] Banyan, D. E., Lundby, A., Ward, A. H., and Walker, D., *Proc. Phys. Soc.*, **62**, 300 (1948).

## Crystal Structure of Ovalene

The synthesis of the hydrocarbon ovalene, or octabenzonaphthalene (Fig. 1) has recently been described by E. Clar[1]. We have now examined the crystal structure of this compound and find it to be remarkably similar to that of the analogous hydrocarbon coronene[2,3]. We are indebted to Dr. Clar for some very beautiful crystal specimens of ovalene, which made this work possible.

The crystals, like those of coronene, are monoclinic, elongated in the *b*-axial direction. X-ray examination gave the following data, the figures in brackets referring to coronene:

$a = 19{\cdot}47$ A. $(16{\cdot}10)$; $b = 4{\cdot}70$ A. $(4{\cdot}695)$;
$c = 10{\cdot}12$ A. $(10{\cdot}15)$; $\beta = 105°$ $(110{\cdot}8°)$.

The space group is $P2_1/a$ ($C_{2h}^5$), and the unit cell contains two centrosymmetrical molecules. (Density, measured 1·496, calc. 1·477.)

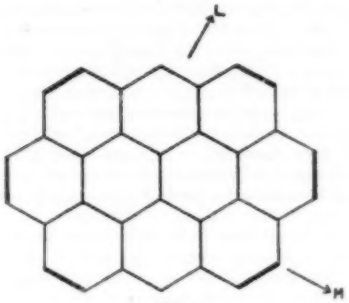



Fig. 1

A more detailed examination of the X-ray spectra, particularly those of the *b*-axial zone, reveals a fundamental similarity to the coronene structure, although there are some significant differences. Trial structures based on the coronene model were found to explain the outstanding features, and a preliminary refinement of the results by the familiar double Fourier series method has now been carried out. This leads to the electron density map shown in Fig. 2, which represents a projection of the crystal structure on the (010) plane, the contour-levels being drawn at approximately unit intervals of electron density. All the carbon atoms are very clearly resolved, and the orientation of the large planar molecule in the crystal can be calculated with some precision. In particular, it is found that the molecular plane is inclined at about 43° to the projection plane, and hence the perpendicular distance between successive molecular planes is about 3·4 A.

The molecular reference axes *L*, *M* and the normal *N* chosen for the coronene crystal structure are not very appropriate for ovalene, but they may be

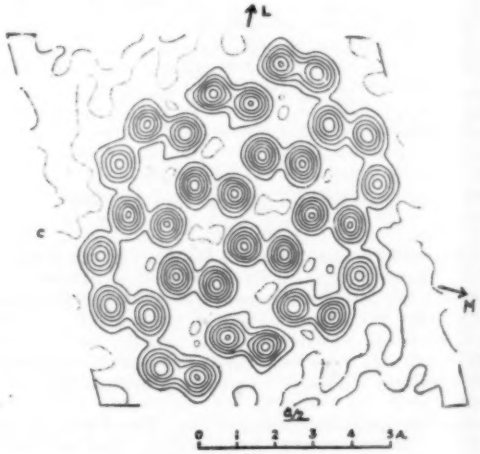



Fig. 2

retained here to facilitate comparison of the two structures. These directions are indicated on Figs. 1 and 2. If $\chi_L$, $\psi_L$, $\omega_L$; $\chi_M$, $\psi_M$, $\omega_M$; and $\chi_N$, $\psi_N$, $\omega_N$ are the angles which these molecular axes make with the $a$- and $b$-crystal axes and their perpendicular, we obtain the following results, the figures in brackets referring to coronene:

| | | |
|---|---|---|
| $\chi_L = 81{\cdot}8°$ (84·8°) | $\chi_M = 44{\cdot}0°$ (44·2°) | $\chi_N = 132{\cdot}8°$ (133·7°) |
| $\psi_L = 82{\cdot}8°$ (85·6°) | $\psi_M = 48{\cdot}1°$ (46·7°) | $\psi_N = 42{\cdot}8°$ (43·7°) |
| $\omega_L = 10{\cdot}5°$ (6·9°) | $\omega_M = 101{\cdot}0°$ (96·8°) | $\omega_N = 89{\cdot}6°$ (89·6°) |

With regard to the carbon–carbon bond-lengths in the molecule, the analysis is not yet sufficiently refined to enable us to measure these with precision. The preliminary results, however, indicate some interesting variations. The exposed bonds on the outside (indicated by heavy lines in Fig. 1) appear on the average to be shorter than the others (1·36–1·38 A.). The average length of all the twenty-two outer bonds is about 1·39 A., while for the nineteen inner bonds we obtain an average of 1·41 A., with some as long as 1·44 A. We expect to obtain more precise values when the structure has been more completely studied.

D. M. Donaldson
J. Monteath Robertson

Chemistry Department,
University of Glasgow.
July 13.

[1] Clar, E., *Nature*, **161**, 238 (1948).
[2] Robertson, J. M., and White, J. G., *Nature*, **154**, 605 (1944).
[3] Robertson, J. M., and White, J. G., *J. Chem. Soc.*, 607 (1945).

## Electrification of Liquid Drops

It has been known for some time that electrification is produced when water breaks into drops, one of the earliest observations being made by Lenard, who found charged drops in the vicinity of a waterfall. This phenomenon is of interest in many ways, one of the most important being in connexion with the production of thunderstorms.

It is a little difficult to see how, as some experimenters appear to suggest, water initially uncharged breaking into drops can on its own, without any other cause, give these drops electric charges. Any argument which gave one a positive charge would equally well give it a negative one. Some recent experiments show that charges are only produced if the break-up occurs in an electric field. The phenomenon then becomes understandable. Water is a conductor—though a bad one—and, if placed in an electric field, positive charges are induced on one side and negative on the other, so that on division these charges separate. If instead of water a non-conducting liquid is used, although the orientation of the dipoles gives the effect of surface charges when in a field, the charges are not separated as in a conductor, and in this case division produces no charged particles. This is analogous to cutting a magnet in half, which does not isolate magnetic poles.

The experiments required the minimum of apparatus. A copper vessel had a hole of about 1 mm. diameter drilled in the bottom. It was filled with water which ran through this hole in a continuous jet. This jet kept together for about 5 cm., and up to this point there was electrical conductivity back to the reservoir. Beyond this, the jet broke up into drops and conductivity disappeared. An insulated vertical copper cylinder was placed around the falling water, and this was charged to various potentials, $V$, between $\pm$ 1,000 volts above earth. The reservoir was kept at earth potential. The water fell into an insulated vessel connected to an electrometer, and was found to be charged the charge $Q$ per c.c. depending on $V$. To a first approximation the water is at zero potential down to the break-up point, so that the break-up occurs in the field between the cylinder charged to $V$ and a central cylinder of water 1 mm. diameter at potential 0.

It was found that $Q$ and $V$ in general had the same sign, and that $Q$ plotted against $V$ gave a straight line which just failed to pass through the origin, missing it by about 0·1 volt.

Thus over the large range of voltage variation + 1,000 to − 1,000, $Q$ is proportional to $V$, which is consistent with the theory of induced charges. The small value of $Q$ when $V = 0$, at first sight, conflicts with the theory that in zero field $Q$ should be nothing; but there is little doubt that it is due to a contact potential difference. When the copper cylinder and copper vessel are both at earth potential, the water is at a slightly different potential and is therefore breaking up in a small field; and the value of $V$ of about 0·1 volt for which $Q$ is zero is a measure of this contact potential between running water and copper. (This method of measurement is being followed up.) There is a good deal of evidence for this, and it will suffice to mention only that the value of $Q$ for zero field for distilled water is different from that for tap water, though the plots are parallel.

Similar experiments with carbon tetrachloride and transformer oil (both extremely good insulators) showed that in these cases an applied field had no effect whatever.

Many experimenters have claimed results in zero fields in regions electrostatically shielded from the earth's field; but this does not eliminate this contact-potential difference between the liquid and the metal with which it was last in contact.

The same considerations apply to sprays, which invariably give off charged drops although everything is apparently at earth potential.

E. W. B. Gill
G. F. Alfrey

Electrical and Clarendon Laboratories,
Oxford.
July 15.

## Atomic Binding Energies

In an earlier paper[1], we published the results of some calculations of analytical atomic wave functions for the ground-states of atoms lithium to neon. Since that time, we have had several requests for the values of the associated total electronic energies. These energies are therefore presented in the accompanying table, where they may be compared with those deduced from experiment. For the lighter atoms these experimental values have been obtained by summing the first, second, . . . ionization potentials of the atoms. For nitrogen, oxygen and fluorine, however, it has been necessary to estimate the last ionization potential by means of a small extrapolation. But the 'experimental' values quoted should all be accurate to about 1 part in 10,000. In no case do the theoretical values differ from the experimental ones by more than 1 per cent. This would still be true if an allowance were made for the motion of the nucleus.

| Atom | State | $\mu$ | $\mu a$ | $\mu b$ | $\mu c$ | Total electronic binding energy calc. | obs. (eV.) |
|---|---|---|---|---|---|---|---|
| Li | $(1s)^2(2s)$, $^2S$ | 0·658 | 2·69 | 2·26 | — | 201·72 | 203·43 |
| Be | $(1s)^2(2s)^2$, $^1S$ | 0·979 | 3·69 | 3·28 | — | 395·87 | 399·04 |
| B | $(1s)^2(2s)^2(2p)$, $^2P$ | 1·322 | 4·69 | 4·20 | 1·20 | 666·24 | 670·8 |
| C | $(1s)^2(2s)^2(2p)^2$, $^3P$ | 1·652 | 5·69 | 5·13 | 1·56 | 1023·12 | 1029·8 |
| N | $(1s)^2(2s)^2(2p)^3$, $^4S$ | 1·970 | 6·68 | 6·08 | 1·91 | 1475·78 | 1485·7 |
| O | $(1s)^2(2s)^2(2p)^4$, $^3P$ | 2·289 | 7·68 | 7·06 | 2·22 | 2027·01 | 2043·3 |
| F | $(1s)^2(2s)^2(2p)^5$, $^2P$ | 2·611 | 8·67 | 8·02 | 2·55 | 2690·6 | 2715·2 |
| Ne | $(1s)^2(2s)^2(2p)^6$, $^1S$ | 2·934 | 9·66 | 8·97 | 2·88 | 3475·6 | — |

The wave functions used in this work[2] are appropriate sums of determinants of the usual type in which the component orbitals are defined to be:

$$\psi(1s) = \sqrt{(\mu^3a^3/\pi)}\exp(-\mu ar).$$
$$\psi(2s) = \sqrt{(\mu^5/3\pi N)}\,[r\exp(-\mu r) - (3A/\mu)\exp(-\mu br)].$$
$$\psi(2p_0) = \sqrt{(\mu^5c^5/\pi)}\; r\cos\theta\exp(-\mu cr).$$
$$\psi(2p_\pm) = \sqrt{(\mu^5c^5/2\pi)}\; r\sin\theta\exp(-\mu cr \pm i\varphi).$$

$N$ is a normalizing factor and $A$ is chosen so that $\psi(2s)$ and $\psi(1s)$ are orthogonal. The appropriate values of $\mu$, $\mu a$, $\mu b$ and $\mu c$ (which are directly related to the effective nuclear charges for the different types of orbit) are also given in the table. They differ slightly from those first suggested by Morse, Young and Haurwitz[2] owing to certain errors, both numerical and analytical, which have crept into their work.

W. E. Duncanson

University College,
London, W.C.1.

C. A. Coulson

Wheatstone Laboratory,
Physics Department,
King's College,
London, W.C.2.

[1] *Proc. Roy. Soc. Edin.*, **62** A, 37 (1944).
[2] *Phys. Rev.*, **48**, 948 (1935).

## A Measurement of the Velocity of Light

In a letter in *Nature*, **142**, 833 (1938), I described a new method of measuring the velocity of light in which Fizeau's toothed wheel was replaced by a piezo-quartz crystal. When placed in an alternating electric field, this has the property of acting as an intermittent diffraction grating. The light in the first-order spectrum is then interrupted two hundred times as rapidly as by Fizeau's toothed wheel.

I have now made a determination of the velocity of light in air by this method. After passing through the quartz, the light travelled a distance of about 39 metres and was reflected back on its path through the quartz to the eye of the observer. For a particular length of path the intensity is a minimum.

The result, reduced to vacuum, is 299,775 km. per sec. The accuracy appears to be about the same as that of other recent determinations; but it is evident from the results that the range could be increased ten times, in which case the accuracy would be ten times as great. A full description of the work will be published elsewhere.

The velocity of light has hitherto been avoided by British physicists, the only other determination made in Great Britain being dated 1881.

R. A. Houstoun

Natural Philosophy Department,
University, Glasgow.

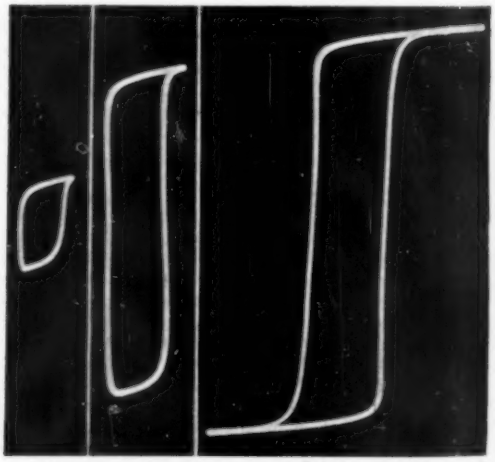
Aug. 22.

## Unsymmetrical Hysteresis Loops in a Nickel–Iron Alloy

In the course of investigations of grain-oriented nickel–iron alloys, a very pronounced asymmetry has been observed in the dynamic hysteresis loop of one particular sample. The effect is demonstrated by momentarily applying a large D.C. magnetizing force to the core and then examining the subsequent hysteresis loops produced by smaller A.C. excitation. Depending on the magnitude of the exciting current the loops appear as in Fig. 1, the magnetizing pulse having previously been applied in the positive direction. The deeper loops result from larger exciting currents.

By means of a flux meter (reading average values) it was found that these loops are not symmetrically located about the origin and become so only when the A.C. excitation produces saturation as in Fig. 2, curve 4. On reducing the excitation the loops again become unsymmetrical. Fig. 2 shows the relative position of these smaller loops with respect to the saturation hysteresis loop of the material. So long as the A.C. excitation is less than the D.C. magnetizing pulse the asymmetry persists. Reversal of the temporary D.C. magnetizing pulse merely reverses the position of the loops. The core may be completely disconnected for days or weeks; on reconnexion the effect is immediately evident again. Observation of the loop as a magnetizing pulse is applied reveals a time delay of about a second as the very distorted loop settles down to one of the shapes shown in Fig. 1. Conversely, on sudden application of the exciting current, a short time is required for the loop to build up to its greatest asymmetry.

Referring now to Fig. 2, consider a value of exciting current such that loop 3 is being traced. It is possible to interrupt this exciting current so that the remanent induction of the core, point $a$, is the negative of that which the last magnetizing pulse would have produced. Re-application of a reduced exciting current causes a small loop to be formed with $a$ as a starting point. This whole loop then moves upward and finally rests at some position like loop 1. As observed with the flux meter, this process is an actual building up of positive flux.



(*a*) (*b*) (*c*)

Fig. 1. (*a*), (*b*) and (*c*) show three successive increases in exciting current. Reduction of the exciting current reverses the steps

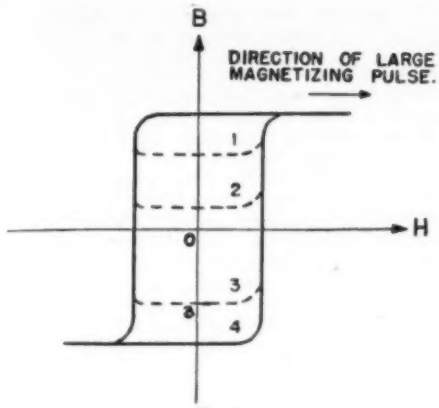



Fig. 2

The only data available for the core material are: 47–50 nickel–iron alloy; 1 per cent aluminium, wound tape strip, 0·002 in. thick, 2½ in. inside diameter, 3½ in. outside diameter, ½ in. wide. The effect has been found to a lesser extent in certain similar nickel–iron alloys, in which an attempt has been made to secure a rectangular hysteresis loop. It has not been found in the usual soft magnetic materials.

Our interest in this phenomenon lies in the fact that such a core acts as a storage device, the stored information being the polarity of the last transient magnetizing pulse. The derivative of the output voltage of a transformer constructed of this material yields a sharp pulse the polarity of which is determined by the direction of the previous magnetizing current. This information may be 'read out' at any convenient rate by the exciting current, can be changed by reversing the polarity of the next magnetizing pulse, and remains stored even if all connexions are broken.

This work has been performed under Contract No. W-19-122 ac-24.

J. L. Rothery

Cambridge Field Station, A.M.C.,
230 Albany Street,
Cambridge, Mass.

An Wang

Harvard Computation Laboratory,
Cambridge, Mass.

## Geodetic Measurements by Radar

Hart[1] has referred to the potential uses of radar in geodesy and photogrammetry. The War Office has now granted permission to publish details of geodetic observations made in Italy by radar during May–June 1945. The general principle of these observations was that an aircraft, a medium bomber with an operational speed of 230 miles per hour, flew a circular arc centred upon a ground radar beacon while the distance from a second beacon was recorded at regular (1–2 sec.) intervals. The geodetic distance between the two beacons was then computed from the radius of the arc and the minimum recorded distance from the second beacon by correcting for altitude and refraction.

In the first experiment, ground beacons were located 126 miles apart at Ancona (43° 33′ 03·31″ N., 13° 36′ 17·49″ E., alt. 1,890 ft.) and Castiglione (44° 06′ 53·97″ N., 11° 11′ 21·35″ E., alt. 3,860 ft.). In the second experiment, beacons were located 384 miles apart at Brescia (45° 32′ 55·80″ N., 10° 17′ 05·54″ E., alt. 2,805 ft.) and Gargano (41° 49′ 13·52″ N., 15° 59′ 05·86″ E., alt. 2,675 ft.). From meteorological observations on the dates of flight, May 29, June 9 and June 11, it was calculated, assuming the formula of Englund, Crawford and Mumford[2]:

$$(\mu - 1) \times 10^6 = \frac{p}{2T}\left\{2{\cdot}11 + \frac{w}{p}\left(\frac{101{\cdot}59}{T} - 0{\cdot}00293\right)\right\},$$

where $\mu$ is coefficient of refraction; $p$ is total atmospheric pressure (mm. mercury); $w$ is partial pressure of water vapour (mm. mercury); $T$ is absolute temperature, that refraction would follow closely the linear law:

$$\mu = \mu_0 (1 - \lambda h), \text{ where } \mu_0 = 1{\cdot}000267 \text{ and } 1/\lambda = 1{\cdot}376 \times 10^5 \text{ ft.}^{-1}.$$

The difference between the true geodetic distance at sea-level and the slant distance between aircraft and ground beacon, as recorded by radar, would then be approximately:

$$\frac{M(h+k)}{2r} + \frac{(h-k)^2}{2M} - \frac{M^3}{24r^2} + \left(\frac{v_0 v_e}{C} - 1\right) M,$$

where $\frac{1}{r} = \frac{1}{\text{radius of curvature of the earth}} - \lambda$ (ft.$^{-1}$);

$C$ is velocity of propagation *in vacuo* (miles per sec.); $v_e$ is velocity of calibration of radar apparatus (miles per sec.); $M$ is slant distance between aircraft and ground beacon (miles); $h$ is altitude of aircraft (ft.); and $k$ is altitude of ground beacon (ft.).

In our case, $1/r = 4{\cdot}052 \times 10^{-8}$ ft.$^{-1}$, $C = 186{,}271$ miles per sec., $v_e = 186{,}218$ miles per sec. Using this formula and converting to metres, taking 1 mile = 1,609·343 metres, the results of the two experiments were as follows.

| Altitude of aircraft (ft.) | No. of flights | Mean observed geodetic dist. (metres) | Standard error of a single observation (m.) | Geodetic distance calculated from geographical co-ordinates |
|---|---|---|---|---|
| Ancona–Castiglione | | | | |
| 10,000 | 4 | 204,121 | 14 | 204,113 |
| Brescia–Gargano | | | | |
| 11,000–12,000 | 4 | 618,332 | 22 | |
| 12,000–13,000 | 5 | 618,349 | 32 | |
| 13,000–14,000 | 9 | 618,356 | 24 | |
| 14,000–15,000 | 4 | 618,352 | 21 | |
| Mean | 22 | 618,349 | 24 | 618,369 |

Thus, assuming the distance based upon the Italian triangulation to be correct (the accuracy of this distance is within 1 part in 100,000), the two distances were measured by radar to an accuracy of 1 part in 25,000 and 1 part in 30,000 respectively. The error may be attributed to lack of knowledge concerning variations in refraction, and hence velocity of propagation, rather than to any inaccuracy in the apparatus, so that the standard of accuracy would not necessarily be improved by increasing the number of determinations. Nevertheless, the method offers useful possibilities for establishing oversea connexions and for rapid triangulation by distance measurement in unsurveyed territories.

I wish to thank the U.S.A.A.F. and R.E. personnel who co-operated in these experiments, and the War

Office (Directorate of Military Survey) for permission to publish the results.

D. J. Halliday

12 Murdoch Road,
Wokingham,
Berks.
July 8.

[1] Roy. Soc. Empire Sci. Conf., 1946.
[2] *Bell System Tech. J.*, **14**, 369 (Appendix) (1935).

## Use of Aspherical Surfaces in the Design of Magnifiers for Binocular Vision

In a recent communication[1], Coulman and Petrie propose that low-power aspherical magnifiers should be designed for coincidence of the two monocular fields of vision rather than for absence of distortion, and suggest that this has not hitherto been done.

In practice, that is scarcely the case, as I shall indicate, but the presentation of the idea may be new and useful. Under the conditions discussed, with the eyes located symmetrically on either side of the lens axis, and at a determined distance from the lens, the suggested correction amounts substantially, and to a Seidel approximation exactly, to the correction of coma for a stop at the position of the eyes. If freedom of eye position is required, the spherical aberration will have to be corrected too, and that will at the same time bring about coincidence of the monocular fields with the binocular field, which is not quite achieved otherwise.

If both spherical aberration and coma are corrected, neither a flat field nor absence of distortion can be achieved with reasonably thin lenses; but in this case the resulting lens is meniscus, of a very different type from that discussed by Coulman and Petrie. But for the type of lens discussed in their communication, there is no reason why the proposed correction should not be combined with the correction of distortion by choice of the correct bending and corresponding degree of aspherization of the lens. In fact, a designer who had nothing but distortion to consider would naturally choose this very form, since it is as convenient as any other for the correction of distortion, and he would have no reason for leaving coma uncorrected. If a head rest is provided to locate the eyes correctly, this form is probably the best.

In the case of lenses used without a head rest, however, reasonable coincidence of the monocular fields in actual use and correction of distortion cannot be ensured together. Moreover, it is desirable in this case to have a reasonably flat field, to minimize the unpleasant one-sided distortion otherwise produced by skewing the lens. The designer must therefore make a compromise between the correction of distortion and of field curvature, which necessitates acceptance of a moderate amount of coma, as well as of some spherical aberration. The exact compromise depends on how the magnifier is likely to be used, or misused, in practice.

Such a compromise leads to a reasonable correction for distortion and curvature over a range of conditions of use, since these corrections are not very sensitive to changes in these conditions.

The coma, however, is much more sensitive to such changes, so that such a lens will, in fact, have the coma corrected, and Coulman and Petrie's condition thereby fulfilled, when the eyes are placed a little nearer to it than was intended by its designer. At this point the compromise between distortion and curvature is likely still to be fairly good.

For example, I designed during the War a lens for use under definite conditions, with an eye distance of about two feet, and I left some coma uncorrected at the eye distance as indicated above. Since the War, this lens, of a very similar diameter and focal length to that described by Coulman and Petrie, has found ready use as a general-purpose magnifier, and it is corrected simultaneously for distortion and for coincidence of the monocular fields at an eye distance and magnification very similar to those assumed in their communication. It is moulded in methacrylate resin ('Transpex 1'), and the paraxial radii of curvature of the surfaces are 13 in. and 3·25 in., the latter surface, facing the eyes, being an ellipsoid the axial section of which is given by the equation $y^2 = x(6{\cdot}5 - 0{\cdot}31x)$.

J. H. Jeffree

Combined Optical Industries, Ltd.,
Plasta Works,
Bath Road,
Slough, Bucks.
Oct. 11.

[1] Coulman and Petrie, *Nature*, **164**, 586 (1949).

## Creation of Matter in the Universe

In a recent article in *Nature*[1], Prof. Max Born introduces Prof. Jordan to British students of cosmology, being, I am sure, under the misapprehension that Jordan and his work were not well known here. In this introduction reference is made to Mr. Hoyle's article in *Nature*[2], where the continuous creation of matter is discussed briefly; the earlier and more complete descriptions of these theories[3,4] were, however, not mentioned.

Prof. Born suggests that Jordan's ideas enable matter to come from an intrinsically unobservable state to an observable one, without infringing any law of conservation of energy; but one may doubt the usefulness of the law, when it permits such a transition. Bondi and I, and later Hoyle, have published theories in which the law of conservation of energy (matter) is taken at its face value: a law capable of experimental verification to a certain precision. If the conjectures of its extrapolation far beyond this precision clash with those theories, then this is regarded as a matter of complete indifference.

Jordan attempts to disguise his bitter pill, for his creation of matter is only the transfer from an unobservable to an observable state; but then his pill is a very large one, for it is entire stars which undergo this remarkable transformation.

There may be a superficial resemblance between the theory of Jordan, and those of Bondi and Gold, and of Hoyle, in that all these authors contemplate that matter may be created currently. But there is no resemblance in the cosmological models which result, or indeed in the purposes to which this additional freedom is put. An expanding but steady-state model of the universe fits all observational material remarkably well, although it is a closely specified model; and such a model requires the continuous creation of matter at a very slight but steady rate. Bondi and Gold introduce the steady state as

an axiom and deduce the consequences; Hoyle obtains it as a consequence of a suitable modification of the general theory of relativity. Jordan's creation of matter does not lead to such a simple and far-reaching concept of the cosmos, and several more assumptions have to be made before a model is obtained which can be compared with observation.

Lastly, a comment has to be made regarding the appeal to observation, or to the opinion of an observational astronomer, which Jordan makes at the end of his article. The question is whether as much intergalactic matter exists as is predicted by Bondi, Gold and Hoyle, and Jordan quotes Dr. Baade as disbelieving this. It must be added, however, that even Dr. Baade's most careful measurements could not be expected to detect this amount of matter, nor indeed amounts very many times as great.

T. GOLD

Trinity College,
Cambridge.

[1] Born, M., and Jordan, P., *Nature*, **164**, 637 (1949).
[2] Hoyle, F., *Nature*, **163**, 196 (1949).
[3] Bondi, H., and Gold, T., *Mon. Not. Roy. Astro. Soc.*, **108**, 252 (1948).
[4] Hoyle, F., *Mon. Not. Roy. Astro. Soc.*, **108**, 372 (1948).

## Effect of Muscular Exercise and of Urethane Administration on the Incorporation of Carbon-14 into Animal Tissue

As a result of the observations described in a previous note[1], according to which irradiation with X-rays influences the pattern of incorporation of carbon-14 into animal tissue, it became particularly important to investigate the effect of muscular exercise on the incorporation of this isotope.

Five minutes after intraperitoneal administration of 4 $\mu$curies of carboxyl labelled acetate to each individual of twenty mice, half the animals were made to swim for twenty minutes. At the end of this period these mice and an equal number of controls were decapitated. The activities were then determined of the dry tissue, of the ether-alcohol extract (fatty fraction) and the protein residue obtained by extraction with trichloracetic acid of the organs listed in the accompanying table. Incorporation of carbon-14 is seen to be significantly decreased in almost all cases.

Similar results were obtained in 3-hr. experiments where swimming was replaced by more moderate exercise, the mice being encouraged to move each time they stopped. The percentage reduction in incorporation was, however, smaller, amounting in most fractions investigated to about 5 per cent only.

In another series of experiments, 20 mgm. of urethane was injected into each of thirty mice, followed by the administration of labelled acetate. The animals obtaining urethane were found after a period of 4 5 hr. to have incorporated markedly more carbon-14 than did the controls. The results listed in the table demonstrate the great sensitivity of this method, in which the incorporation of carbon-14 in tissue fractions serves as an index of particular metabolic processes. The usual methods, such as the comparison of the $Q_{CO_2}^{N_2}$ or the $Q_{O_2}$ values of surviving tissue slices of urethane-treated mice (20 mgm. per animal) and of controls do not show any significant difference. Thus in this way Boyland and Rhoden[2]

Effect of (*a*) muscular exercise and (*b*) urethane administration on the incorporation of carbon-14 into tissue constituents of mice. Each mouse injected, 26,600 counts

| Fraction | (*a*) 20 min. (19·0 gm. mouse) Counts per min. Control | Swimming | % change | (*b*) 270 min. (21·2 gm. mouse) Counts per min. Control | Urethane | % change |
|---|---|---|---|---|---|---|
| Plasma total | 97·0 | 76·6 | −21 | 65·0 | 75·4 | +16 |
| Liver total | 156·5 | 115·2 | −26 | 57·2 | 94·1 | +67 |
| Liver fatty products* | 50·5 | 38·3 | −24 | 15·7 | 29·7 | +89 |
| Liver glycogen | 20·4 | 16·0 | −22 | — | — | — |
| Kidney total | 55·5 | 53·1 | − 4 | 35·5 | 38·6 | + 9 |
| Kidney fatty products | 14·3 | 12·0 | −17 | 6·6 | 7·5 | 15 |
| Kidney protein | 15·8 | 16·0 | + 1 | 30·2 | 34·1 | +13 |
| Intestinal mucosa total | 188·6 | 179·2 | − 5 | 143·6 | 117·8 | +24 |
| Intestinal mucosa fatty products | 41·2 | 35·7 | −13 | 24·1 | 36·0 | +50 |
| Intestinal mucosa protein | 41·2 | 35·7 | −13 | 152·4 | 166·6 | + 9 |
| Muscle total | 18·1 | 15·4 | −15 | 8·2 | 10·8 | +32 |
| Muscle fat | 8·3 | 10·4 | +25 | 2·0 | 3·0 | +50 |
| Muscle protein | 4·2 | 3·1 | −26 | 4·2 | 5·4 | +29 |
| Brain total | 23·9 | 20·7 | −13 | 13·1 | 13·7 | + 5 |
| Brain fat | 5·7 | 5·7 | 0 | 3·6 | 4·0 | +11 |
| Brain protein | 1·4 | 1·1 | −21 | 13·7 | 15·2 | +27 |

* The ether-alcohol soluble fractions were transformed into barium carbonate previous to activity measurement. Correspondingly the figures have to be multiplied by 7·7 to make them comparable with the protein-activity figures.

were not able to detect the effect of urethane on tissue metabolism[3]. On the other hand, its depressing effect on tissue metabolism is clearly brought out by the above figures.

Carbon-14 of the acetate administered can be incorporated into other carbon compounds either after oxidation to carbon dioxide or directly without oxidation. For example, acetate may contribute carbon atoms to the glucose units of glycogen by pathways other than those of oxidation and carbon dioxide fixation[3]. In both cases increased catabolism as such produced by muscular exercise can be expected to lead to a diminished incorporation of carbon-14 into many of the tissue constituents. Following the injection of labelled acetate, apart from a brief initial period, as shown by Gould and associates[4] the specific activity of the carbon dioxide decreases very markedly with time. This decrease is interpreted as being primarily due to a dilution of radioactive carbon dioxide of the body fluid with normal carbon dioxide resulting from other metabolic processes. An increased metabolism can thus be expected to lead to an increased rate of dilution and to a correspondingly enhanced rate in the decrease of the specific activity of the labelled carbon dioxide with time, leading in turn to a decrease in the amount of carbon-14 incorporated into the tissue constituents.

If the acetate carbon is incorporated into organic compounds by pathways other than those of oxidation and carbon dioxide fixation, increased catabolism will act in a similar way on the incorporation of carbon-14 into the tissue constituents. Thus labelled acetate administered may be very appreciably diluted by endogenous body acetate[3] formed in the course of catabolic processes. Increased catabolism can thus be expected to promote dilution and to diminish the specific activity of the labelled acetate.

A decreased catabolism, as produced for example by the administration of urethane, can be expected to act in the opposite direction, slowing down the decrease in the specific activity of carbon dioxide

and acetate with time and thus promoting incorporation of carbon-14 into tissue constituents.

Muscular exercise and urethane administration may influence the rate of incorporation of carbon-14 into tissue constituents by acting on other metabolic steps than those mentioned above; such an influence is indicated by the observed increase following muscular exercise in the carbon-14 content of the fatty fractions of the muscles and in some experiments also in those of the intestinal mucosa. Nevertheless, the dilution effect is presumably to a large extent responsible for the changes observed in the incorporation of carbon-14 following muscular exercise and urethane administration.

The carbon-14 content of the average total tissue is found to be about twice as large after the lapse of 20 min. as after the lapse of 4·5 hr. This is mainly due to the fact that the proportion of non-metabolized acetate in the tissue is very much larger after 20 min. than after 4·5 hr., and also that the fatty components present, being renewed at a very rapid rate, are more active after 20 min. than after 4·5 hr. The probability of carbon-14 taken up by the protein being lost again within a few hours is small, and correspondingly the average tissue protein activity after the lapse of 20 min. is about one-third only of the value observed after the lapse of 4·5 hr.

I wish to thank Dr. Ehrensvärd for preparing the labelled acetate, and Miss Grace de Elliott and Miss Gertrud Dreyfus for their valuable assistance.

G. Hevesy

Institute for Research in Organic Chemistry,
University of Stockholm,
and
Pharmacological Laboratory of the
Karolinska Institute.
Oct. 4.

[1] Hevesy, G., *Nature*, **163**, 869 (1949).
[2] Boyland, E., and Rhoden, E., *Biochem. J.*, **44**, 528 (1949).
[3] Lorber, V., Lifson, N., and Wood, H. G., *J. Biol. Chem.*, **161**, 411 (1945). Bloch, K., *Phys. Rev.*, **27**, 595 (1947). Gordon, G. R., Hastings, A. B., Anfinsen, Ch. B., Rosenberg, I. N., Solomon, A. K., and Topper, Y. J., *J. Biol. Chem.*, **177**, 727 (1949).
[4] Gould, R. G., Sinex, F. M., Rosenberg, I. N., Solomon, A. K., and Hastings, A. B., *J. Biol. Chem.*, **177**, 295 (1949).
[5] Ponticorro, L., Rittenberg, D., and Bloch, K., *J. Biol. Chem.*, **179**, 839 (1949).

## Hæmolysis by Newcastle Disease Virus

For a number of years it has been known in this laboratory that hæmolysis of moderate degree may occur when red cells are being treated with the viruses of mumps and Newcastle disease. This is not characteristic of any of the influenza viruses. The hæmolysis was of slight degree and apparently irregular in its occurrence. Following the appearance of the paper by Morgan, Enders and Wagley[1] on mumps virus hæmolysis, it was noted that when dilutions of Newcastle disease virus were made in phosphate solution instead of physiological saline, both fowl and human red cells were more extensively lysed. A comprehensive study of the phenomenon was afterwards begun.

The hæmolytic action of Newcastle disease virus appears to resemble in essential respects that shown by mumps virus, but differs greatly from any other type of hæmolytic effect. The most striking feature is the complete absence of hæmolysis of cells from which 'virus receptors' have been removed either by virus action or treatment with the cholera vibrio enzyme.

Hæmolysis is inhibited by low concentrations of calcium ions, and typical infected allantoic fluids have very little hæmolytic action when used undiluted unless a calcium-deionizing agent such as citrate is added. Most of the work has been done with preparations of virus eluted from red cells into saline lightly buffered at *p*H 7·35 with phosphate, or with virus precipitated by methanol in the cold according to the technique of Cox *et al.*[2] and dialysed against buffered saline.

The course of hæmolysis of washed fowl erythrocytes differs characteristically according to which of these preparations is used. At 37° the eluate shows a lag period of 30–40 min. before hæmolysis is detectable; with the methanol-precipitated virus the lag period ranges from 1½ to 4 min., according to the concentration of virus used. With methanol-precipitated virus in amount corresponding to about a hundred agglutinating doses and in a 2 per cent suspension of red cells, hæmolysis proceeds to about 90 per cent completion within 15 min. and then ceases. With progressively smaller concentrations of virus, the level at which hæmolysis virtually ceases falls. Over a fairly wide range, the level is approximately proportional to the logarithm of the virus concentration. Eluate virus gives similar results, but the time needed to reach the final level of hæmolysis is longer and the level itself considerably lower than with methanol-precipitated virus.

Hæmolytic activity is destroyed by heating in phosphate or phosphate saline to 54° C. for 30 min. without damage to hæmagglutinating capacity and with retention of infectivity for chick embryos. It is neutralizable by specific immune sera to titres corresponding closely to their anti-hæmagglutinin titres.

All the experimental results so far obtained are in accord with the view that the hæmolytic agent is the virus particle itself, and that hæmolysis cannot occur unless the virus particle is adsorbed to the cell surface by the well-known receptor mechanism. It is possible to prevent hæmolysis by Newcastle disease virus by prior treatment of the cells with the same virus under appropriate conditions, for example, in the presence of excess calcium ions. This makes it highly probable that there are at least two competitive types of interaction between virus and cell receptor, and that hæmolysis ceases when all remaining intact cells have lost their receptors as a result of the other (non-hæmolytic) reaction.

If the hæmolysis is due to an enzyme carried by the virus, it would appear that this enzyme is distinct from that responsible for the destruction of cell receptors which is present in all influenza viruses as well as in Newcastle disease virus. Hæmolytic action is lost at a temperature well below that which seriously reduces the enzymic action of Newcastle disease virus on ovomucin, and calcium ion inhibits hæmolysis while it favours slightly the receptor-destroying activity of the virus.

A full account of these experiments will be published elsewhere.

F. M. Burnet

Walter and Eliza Hall
Institute of Medical Research,
Sydney Road,
Melbourne.
July 14.

[1] Morgan, H. R., Enders, J. F., and Wagley, P. F., *Aust. J. Exp. Biol. and Med. Sci.*, **26**, 503 (1948).
[2] Cox, H. R., Van der Scheer, J., Alston, S., and Rohnel, E., *J. Immun.*, **56**, 149 (1947).

## Enzymatic Degradation of Desoxyribose Nucleic Acid by Crystalline Desoxyribonuclease

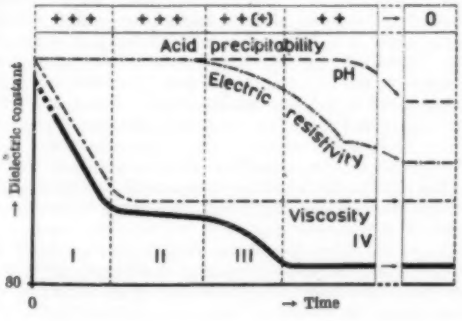
As has been shown in this laboratory, the dielectric increment per gram per litre of desoxyribose nucleic acid in aqueous solution as sodium salt is proportional to molecular weight. Thus, enzymatic degradation of poly-desoxyribose nucleic acid by Kunitz's[1] crystalline desoxyribonuclease (supplied by the Worthington Biochemical Laboratory, Freehold, New Jersey) may be followed by determinations of dielectric constant.

The method used—Fürth's ellipsoid method adapted to high frequencies—is not suited for following the action of the enzyme under its optimal conditions. By increasing the enzyme concentration, however, sufficiently high activity was obtained. The substrate used was sodium desoxyribose nucleic acid isolated from calf thymus by Hammarsten's procedure[2]. Generally, a 0·025 per cent solution containing 0·0001 *N* magnesium ions and 0·005 per cent gelatine has been investigated at a temperature of 20° C. The enzyme concentration has been varied between 0·01 and 0·1 mgm. per ml.

As is shown in the accompanying diagram, four different stages of breakdown are obtained. In the first (I), the increment decreases almost linearly with time. Determinations at various frequencies within the anomalous dispersion region have shown that the average molecular weight decreases with the increment as expected. After 10–20 min. the increment becomes almost stable (stage II). When using high enzyme concentrations there is a sharp change from stage I to II, and the level of the increment which characterizes stage II is in inverse ratio to the enzyme concentration. At low enzyme activities the boundary is diffuse and the increment decreases slowly during stage II. Stage III is characterized by a strikingly rapid decrease of the increment to a considerably lower level. The time when this decrease begins depends upon the enzyme concentration and can take place from 10 min. to several hours after the beginning of stage II. Stage IV constitutes the ultimate condition from a dielectric point of view, there being no detectable change of the increment during 24 hr.

Our experimental conditions are suboptimal and not directly comparable with the conditions usually employed[3–6]. A certain correlation is, however, possible. The diagram shows schematically the variation of the relative values of acid precipitability, *p*H, high-frequency resistivity and viscosity during the different stages.

The genuine 'depolymerase' effect, namely, disaggregation of desoxyribose nucleic acid[7], appears in stage I. The almost stationary condition found in stage II may be explained as being due to a splitting off of smaller components—having little effect on the increment—from the desoxyribose nucleic acid. The peculiar rapid change of the increment in stage III seems to be due to an acceleration by the reaction products of the nuclease activity. To investigate this, further additions of desoxyribose nucleic acid have been made at different times. Additions made during stage II lead to mainly additive increment and the enzyme activity remaining unchanged. Additions in the beginning of stage IV result in the new initial stage being at least as rapid as when the enzyme is added to unchanged substrate, while stage II nearly disappears. It cannot be excluded, however, that in stage III a different enzyme is concerned. In stage IV, which is inaccessible to dielectric investigation, important changes occur, with the appearance of dialysable products.




G. Jungner
I. Jungner
L.-G. Allgén

Biochemical Department,
Karolinska Institutet,
Stockholm.
Aug. 31.

[1] Kunitz, M., *Science*, **108**, 19 (1948).
[2] Hammarsten, E., *Biochem. Z.*, **144**, 383 (1924).
[3] McCarty, M., *J. Gen. Physiol.*, **29**, 123 (1946).
[4] Greenstein, J. P., *J. Nat. Cancer Inst.*, **7**, 29 (1946).
[5] Zittle, C. A., *Arch. Biochem.*, **13**, 191 (1947).
[6] Zamenhof, S., and Chargaff, E., *J. Biol. Chem.*, **178**, 531 (1949).
[7] Jungner, G., Jungner, I., and Allgén, L.-G., *Nature*, **163**, 849 (1949).

## 'Vegetative Hybridization'

Much has been written about the experiments and scientific conclusions of Lysenko and his collaborators. There has, however, been almost no attempt at an actual critical confirmation of the Russian results. Thus, although the experiments on 'vegetative hybridization' have formed a large part of the basis for certain theories suggested by Lysenko, there has, as yet, been no published account in Great Britain of a repetition of any of these investigations. In view of this lack of information, it was decided to repeat one of the Russian experiments on 'vegetative hybridization' in the tomato, and the present communication summarizes the results in the year of grafting.

Among the Russian investigators, Avakjan and Jastreb[1] reported changes in tomato grafts, including one in which a variety with red fruit was used as stock and grafted with a pale yellow variety as scion. The scion produced fruits which were red, pink, yellow, or yellow with pink stripes. Some of these colour changes were transmitted to the progeny. Gluščenko[2] also reports changes in both grafted plants and their progeny. An example of a change in the year of grafting is his account of a tomato variety with ordinary tomato leaves grafted on to a tomato variety with potato-type leaves. The developing scion is described as producing both tomato and potato-type leaves.

In the description of actual grafting technique, Lysenko and his co-workers have latterly emphasized the need for taking the graft components at different ages. When one plant is grafted on to another, the plant used as scion, the characters of which it is desired to change, should be very young, whereas

the plant used as stock should be older and more mature. When the graft has taken, the scion should be defoliated as fully as possible without damaging the further growth of the plant. In an attempt to test the results of Avakjan and Jastreb, Wilson and Withner[3] made reciprocal grafts between varieties of tomatoes differing in fruit-colour, fruit-shape and fruit-size. They found no changes in the visible characters of the grafted plants. In their experiments, however, both stock and scion were of the same age, and the scions were not defoliated until after the fruit had set.

I have attempted to repeat exactly the later techniques described by the Russian investigators. The tomato varieties used differ in two genetically controlled characters, namely, the type of leaf and the colour of fruit. The variety Golden Sunrise has ordinary tomato leaves and yellow fruit, whereas the variety Open Air Wonder has potato-type leaves and red fruit. The graft was made in a cleft, graft components being taken at different ages. At the time of grafting, the stock was in the eight–nine node stage with a stem height of approximately 15 in. while the scion was still in the two-leaf stage. In most of the grafts nearly all the leaves of the scion were removed as soon as they were formed. As a control on the effects of defoliation, no leaves were removed in some of the grafts. Fruits were obtained from the following graft combinations: 29 plants of Open Air Wonder (scion) grafted on Golden Sunrise (stock), 21 plants of Golden Sunrise (scion) grafted on Open Air Wonder (stock), 6 plants of Golden Sunrise (scion) grafted on Golden Sunrise (stock), and 6 plants of Open Air Wonder (scion) grafted on Open Air Wonder (stock); 15 plants of Open Air Wonder and 15 plants of Golden Sunrise served as ungrafted controls.

The results of this experiment clearly show that in the year of grafting there has been no observable influence on fruit colour or leaf-shape by either stock or scion. These results, therefore, do not support the claims of the Russian workers.

Although consideration of the fruit colours needs no further comment, it is worth while noting that certain changes in leaf-shape can be found even in ungrafted plants. In both ungrafted Open Air Wonder and ungrafted Golden Sunrise, the first two or first four leaves of some lateral branches differ in shape from the leaves formed later. Thus in some lateral branches of the tomato-leaved variety Golden Sunrise, the first two leaves are almost like those of the potato-type leaf variety Open Air Wonder, whereas the leaves formed later are of the ordinary tomato shape. In the absence of ungrafted controls, this change of leaf-shape on a grafted plant might have suggested a 'vegetative hybrid' according to the Lysenko interpretation. This type of variation in the leaf character may therefore account for the phenomenon observed by Gluščenko in the year of grafting and attributed by him to 'vegetative hybridization'.

Further results dealing with behaviour in subsequent generations will be published in due course.

L. Sachs

Plant Breeding Institute,
School of Agriculture,
Cambridge.
Oct. 20.

[1] Avakjan, A. A., and Jastreb, N. G., *Jarovizacija*, **1**, 50 (1941).
[2] Gluščenko, I. E., "Vegetative Hybridisation in Plants" (Ogiz-Seljohzgiz, Moscow, 1948).
[3] Wilson, K. S., and Withner, C. L., *Amer. J. Bot.*, **33**, 796 (1946).

## Are Aquatic Phycomycetes Present in the Air?

In the course of a study of the seasonal variation of micro-organisms in the air of Montreal, in connexion with departmental studies on airborne fungi[1], nutrient agar plates were exposed at regular intervals by the *G—E* Duplex electrostatic bacterial air sampler[2] on the roof of the Biological Building of McGill University. The number of micro-organisms per cubic foot air was readily calculated from the countings of colonies versus times of exposure, the sampler having a uniform flow of 1 cu. ft. per min. The length of the sample was ten minutes. Among many common species of bacteria, actinomycetes, yeasts and moulds, an interesting aquatic phycomycete later identified as *Hyphochytrium catenoides* Karling was encountered. This organism was found on an agar plate 223 exposed on the positive electrode of the sampler in the morning of April 29, 1949, on the roof of the Biological Building of McGill University. The weather that morning was clear, with the air temperature 48–50° F. and light winds. In the past week, it had been mainly overcast or cloudy, with occasional light rains and showers. There were altogether eighty-two colonies on the plate, including seventy-two bacteria, one actinomycete, one yeast and seven other fungi. The colony of this fungus was well isolated, slightly raised, pale yellow, slimy, yeast-like, and had attained a diameter of 5 mm. The medium used in this investigation was Czapek's solution agar modified by substitution of 5 gm. glucose instead of sucrose and the addition of 1 gm. yeast extract per litre. All plates were incubated at 24° C. for 10–14 days before examination.

When first isolated, the identity of the fungus was uncertain. The gross morphology and particularly some sporangia provided with papillæ suggested the possibility of its being an aquatic phycomycete. Attempts were made to grow the fungus on boiled decolorized grass leaves, 'Cellophane' paper and hemp seeds in distilled water. All yielded good growth, and discharge of zoospores from exit tubes was observed in many cases. Monosporic cultures were obtained by picking up single zoospores on agar plates. The zoospores have a single anterior flagellum. The morphology fits fairly well the description of *H. catenoides* which has been extensively studied by Karling[3], and will not be detailed here.

It grows well on most of the agar media tested, and cultural characteristics vary a great deal on different media. When zoospore suspensions are sown on agar plates, tiny colonies develop in a few days at 24° C. Zoospores can be obtained in abundance in less than three hours when such young cultures are immersed in running tap water. Zoosporogenesis has been observed to be the same as that described by Karling[3]. The zoospores are spherical when first dispersed, but later become oval during their active swimming stage. They are 2·2–2·75 × 3·3–4·4 $\mu$ in size with one anterior flagellum up to 14·85 $\mu$ in length. Both the character and attachment of the flagellum were ascertained under the dark field. On staining with Loeffler's technique[4], the structure of the flagellum was found to be of the tinsel type.

In old cultures, the zoosporangia become more or less thick-walled, with a denser cell content. They are not so easily induced to germination even after having been placed in running water for several days. So

far, no true resting sporangia have been observed in either agar or water cultures.

The present species was first found by Karling[5] as a contaminant growing in the trichomes of corn while he was working with the physoderma disease. It was described as a weak parasite and saprophyte in trichomes and parenchyma cells of corn and in cooked internodes of *Chara* and *Nitella*. The origin of this fungus was, however, uncertain. In view of the present investigation that it can be readily isolated from an agar plate exposed for airborne organisms, its occurrence in the air seems highly possible.

I wish to acknowledge my appreciation to Prof. S. M. Pady for his advice and helpful suggestions.

This communication was written while a student at the Department of Botany, McGill University, Montreal.

WAN-NIEN SIANG

Department of Plant Pathology,
Washington State College,
Pullman,
Washington.
Nov. 3.

[1] Pady, S. M., Kelley, C. D., and Polunin, N., *Nature*, **162**, 379 (1948).
[2] Luckiesh, M., Taylor, A. H., and Holladay, L. L., *J. Bact.*, **52**, 55 (1946).
[3] Karling, J. S., *Amer. J. Bot.*, **26**, 512 (1939).
[4] Couch, J. N., *Amer. J. Bot.*, **28**, 704 (1941).

## Enhancement by 'Visible' Light of Recovery from Ultra-Violet Irradiation in Animal Cells

DULBECCO[1] has reported that exposure to visible light in the presence of bacterial cells enhances reactivation of *coli*-bacteriophage which has been inactivated by ultra-violet radiation. Kelner[2] reported earlier this year that visible light enhances the recovery of conidia of *Streptomyces griseus* which have been treated with ultra-violet radiation. Some years ago, Whitaker[3] found what may have been the same kind of effect in the eggs of the alga, *Fucus furcatus*.

The present note is to report a similar finding in echinoderm eggs, the first case involving animal cells, and thus extending widely the occurrence of this phenomenon. Short doses of ultra-violet radiation (wave-length less than 3200 A.) cause the delay of subsequent cleavages of the eggs of the sea urchin *Arbacia punctulata*. Gradual recovery occurs, until after a few cleavages the normal cleavage-rate is regained. The return to normal rate is greatly accelerated by light from the short end of the visible spectrum (wave-lengths of approximately 4000-5000 A. as determined in preliminary studies).

Since the effect is so widespread, it is cogent to ask whether some ubiquitous substance is the light absorber in all these cases, and this idea is supported by the general agreement between the range of the action spectrum found by ourselves and that found by Dulbecco in an unrelated organism. The spectral region suggests a carotinoid or possibly riboflavin as the light absorber; these substances are widely distributed and photoactive. It seems unlikely that echinochrome, the characteristic pigment of these eggs, is the light absorber for this effect, because of its spectral absorption. Studies of the action spectrum in various other organisms are desirable.

Attempts to demonstrate this effect in human skin have failed thus far. Skin receiving an erythemic threshold dose of ultra-violet radiation from an artificial source was afterwards exposed to sunlight from which the wave-lengths producing erythema were removed by window glass. The doses of the latter were far in excess of those which would be received in the course of exposure to a threshold erythemal dose of natural sunlight. The average from experiments on seven persons indicated no effect of visible light on the threshold; but the error of such measurements is high[4], and the experiments too few to rule out a small effect. If some recovery does occur, these experiments indicate that it is probably too small to have great importance as regards sunburn.

HAROLD F. BLUM
GORDON M. LOOS
JUDITH P. PRICE
J. COURTLAND ROBINSON

National Cancer Institute;
Department of Biology,
Princeton University;
and the
Marine Biological Laboratory,
Woods Hole.
July 21.

[1] Dulbecco, R., *Nature*, **163**, 949 (1949).
[2] Kelner, A., *Proc. U.S. Nat. Acad. Sci.*, **35**, 73 (1949).
[3] Whitaker, D. M., *J. Gen. Physiol.*, **25**, 391 (1942).
[4] Blum, H. F., and Terus, W. S., *Amer. J. Physiol.*, **146**, 107 (1946).

## Micro-Anatomy of the Hepatic Circulation

IN the course of studying the role of circulatory changes in the pathogenesis of centrilobular hepatic lesions[1,2], we have been attempting by various techniques, including the use of neoprene latex and indian ink[3], to clarify certain controversial points in the normal liver circulation.

(1) The branches of the portal vein and hepatic artery which reach the parenchyma spread out to form an apparently continuous network of vessels resembling large sinusoids, from which smaller sinusoids radiate into the lobules. This network appears to lie near the junction of the parenchyma and portal tracts and, in this sense, may be regarded as periportal. It is most distinct around the larger portal tracts and less clearly defined as the tracts become smaller.

The network continues into the hilar region and is spread irregularly over the subcapsular liver surface, where it receives a richer arterial supply than in the deeper substance. Small branches of the portal vein penetrate to the subcapsular region and can be seen breaking up to form the large sinusoidal vessels making up the network.

(2) The network is supplied by branches of the portal vein in two ways: (*a*) by short vessels which terminate soon after passing the limits of the portal space, and (*b*) by offshoots from larger branches leaving the parent ramification. The 'short' vessels (Fig. 1) are more frequent towards the termination of the portal venous branches.

A loose venous and arterial plexus lies in the larger portal spaces and in the hilar region, and sends branches to the periportal network. No anastomosis between veins of different portal tracts has been seen within the liver, other than via the sinusoids.

Branches of the portal vein are accompanied by branches of the hepatic artery which may be multiple. The arteries give off many small branches which

enter the sinusoids through the periportal network mentioned above. Other arterial branches supply both the portal vein itself and a plexus which surrounds the bile duct. There is some anastomosis between arterial branches of different portal tracts mainly via the subcapsular arterial plexus.

(3) In the mammals so far studied, namely, man, dog, cat, rabbit and guinea pig, there is a well-marked plexus around the branches of the bile duct (Fig. 2). We presume this is the 'arterial' capillary plexus referred to by Mall[4] and others. It is especially prominent around the cystic duct and gall bladder. It is connected chiefly to the portal venous system by both small, direct communications and by branches from the vessels which supply the periportal network. The arterial supply is much less extensive. In places this plexus collects into larger vessels which enter the sinusoidal network.

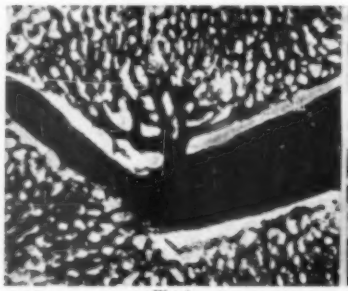


Fig. 1

Fig. 2

Fig. 1. Indian ink preparation. Portal vein showing a 'short' branch supplying large sinusoids, some of which run parallel to the portal tract

Fig. 2. Neoprene cast. The background is formed by a branch of the portal vein and clumps of sinusoids. The hepatic arterial branch is dark, and below it lies the peribiliary plexus communicating with the sinusoids

(4) Terminally, the branches of both the hepatic artery and portal vein enter large sinusoids which divide into smaller ones.

(5) The hepatic venous circulation is simpler. Sinusoids drain directly into the central veins, and, in places, into much larger vessels. Sinusoids are often locally collected into short trunks which pass into the larger vessels at right angles to their surfaces. There is no network equivalent to that seen in the periportal circulation.

The portal venous and hepatic arterial circulations do not appear to have direct connexion with the hepatic venous circulation, except through sinusoids.

We could find no direct evidence of anastomosis between the portal vein and the hepatic artery within the portal tracts. The existence of the network of vessels described above, however, strongly suggests that blood reaching the lobule is mixed arterial and venous. There is a high degree of branching and anastomosis of the sinusoids themselves.

W. H. Horner Andrews
B. G. Maegraith
C. E. M. Wenyon

School of Tropical Medicine,
Pembroke Place,
Liverpool 3.
June 22.

[1] Maegraith, B. G., and Findlay, G. M., *Lancet*, ii, 403 (1944).
[2] Maegraith, B. G., Andrews, W. H. Horner, and Gall, D., *Lancet*, ii, 781 (1947).
[3] Andrews, W. H. Horner, and Maegraith, B. G., *Ann. Trop. Med. and Parasit.*, **42**, 95 (1948).
[4] Mall, F. P., *Amer. J. Anat.*, **5**, 227 (1906).

## Water Content of Saliva Dried at Various Humidities

In calculations relating to the aerial bactericidal action of certain α-hydroxy acids, it was noted that the calculated rates of diffusion of these acids into air-suspended salivary particles, when plotted against the water content of the particles, did not appear to extrapolate to the expected diffusion-rate in pure water at 100 per cent water content[1]. It was suggested that this might be due to the formation of a shell of dried material on the outside of the particles so that the water content of the particle as a whole, some minutes after its formation, exceeded that of the outer layers, the estimated diffusion-rates being largely determined by the water content of these layers. Measurements of the equilibrium water content of saliva dried at various relative humidities confirm that, at relative humidities greater than 50 per cent, the water content of the salivary particles some minutes after their formation exceeds the equilibrium value.

The measurements were made at room temperatures, 18–20° C., using 0·25 c.c. of saliva from a healthy subject for each determination. The standard error of a determination appeared to be about 20 per cent. The accompanying table shows smoothed values for the equilibrium 'free' water content, derived from some fifty observations, compared with the published figures for the water content of air-suspended salivary particles some minutes after their formation[2].

| Relative humidity (%) | 'Free' water content (%) | |
|---|---|---|
| | Equilibrium value | Air-suspended particles |
| < 1 | (0) | (0) |
| 10 | 2 | — |
| 30 | 9 | 8 |
| 50 | 22 | 25 |
| 70 | 37 | 51 |
| 90 | 52 | 78 |

When these equilibrium values of the 'free' water content, which may be supposed to correspond to the 'free' water content of the outer layers of the air-suspended salivary particles, are plotted against the logarithms of the rates of diffusion of the α-hydroxy acids into such particles, deduced from measurements of their aerial bactericidal action, the resulting line, extrapolated to 100 per cent water content, is consistent with the diffusion-rates of similar substances in pure water.

O. M. Lidwell

Medical Research Council Group for
Research in Industrial Physiology,
Harvard Hospital,
Coombe Road,
Salisbury, Wilts.
July 20.

[1] Studies in Air Hygiene: Medical Research Council Special Report Series No. 262, Section 20, p. 118 (London: H.M. Stationery Office).
[2] *Ibid.*, p. 107.

## Extraction of a Specific Antigen from the Virus of Lymphogranuloma venereum

MANY studies have been made concerning the antigenic structure of viruses of the psittacosis-lymphogranuloma group as revealed by the complement-fixation technique; these include experiments recently reported on the effect of various reagents on psittacosis virus[1]. It was shown that 0·001 molar potassium periodate destroyed the serologically active heat-stable group antigen of heated virus suspensions, while leaving some reactivity, due to the labile specific component, in similar but unheated preparations. The possibility that skin tests might be used for demonstrating the specific behaviour of virus treated with the same reagent was considered, since it is recognized that the preparations which have been or are used for this method of diagnosing lymphogranuloma venereum[2,3,4] produce skin reactions which are largely or entirely due to the group antigen[5,6]. Heated yolk-sac suspensions of both psittacosis and lymphogranuloma venereum viruses have, in this laboratory, given closely parallel results in patients with lymphogranuloma venereum[7].

Preliminary tests showed, however, that periodate, even in 0·01 molar concentration, did not alter the effect of heated suspensions of lymphogranuloma venereum virus in the skin of known reactors. This difference between the behaviour of the treated material in the complement-fixation reaction and in the skin test might be due to the fact that the amount of serologically active group antigen in the virus particle is very much less than that which plays a part in the allergic reaction.

It was thought that skin tests of another type of virus preparation might repay trial. The earlier serological experiments had also shown that dilute acid had an effect on elementary body suspensions like that of heat; the activity of the group antigen was enhanced, presumably owing to the destruction or solution of the specific component which gave inferior and irregular antibody reactions. It had not been possible to demonstrate by complement fixation any activity in clear supernatant fluids separated from acid-treated virus suspensions; Dr. R. R. A. Coombs very kindly tested the materials by the more sensitive conglutinating complement-absorption test[8] and also obtained negative results.

Extracts prepared by treating partially purified yolk-sac suspensions of psittacosis and lymphogranuloma venereum viruses with 0·02 *N* hydrochloric acid at 37° C. for twenty minutes were neutralized, the precipitate discarded, and tested undiluted in the skin of two patients who had recovered from psittacosis and five patients with lymphogranuloma venereum. Heated and diluted suspensions of normal yolk sac and of psittacosis and lymphogranuloma venereum viruses were also used. Both the psittacosis patients reacted to the heated homologous virus; one of them, infected fifteen years previously, gave no other reaction; but the second patient, six months after infection, reacted to the psittacosis virus extract as well. In the lymphogranuloma venereum patients it was found that heated suspensions of either virus could be used with equal effect, but that, of the extracts, only the homologous virus produced positive results; these preparations were uniformly specific. It thus appears that acid treatment of these two viruses carries into solution a specific antigen which, in that state or concentration, can be demonstrated by its skin reactivity but not by complement fixation.

C. F. BARWELL

Department of Bacteriology,
London Hospital and Medical College,
London, E.1.
July 22.

[1] Barwell, C. F., *Nature*, **162**, 460 (1948).
[2] Frei, W., *Klin. Wchnschr.*, **4**, 1248 (1925).
[3] Grace, A. W., and Suskind, F. H., *Proc. Soc. Exp. Biol.*, **32**, 71 (1934).
[4] Grace, A. W., Rake, G., and Shaffer, M. F., *Proc. Soc. Exp. Biol.*, **45**, 259 (1940).
[5] Pollard, M., and Witka, T. M., *Tex. Rep. Bio. and Med.*, **5**, 288 (1947).
[6] Rake, G., Eaton, M. D., and Shaffer, M. F., *Proc. Soc. Exp. Biol.*, **48**, 528 (1941).
[7] Bedson, S. P., Barwell, C. F., King, E. J., and Bishop, L. W. J. (to be published).
[8] Hole, N. H., and Coombs, R. R. A., *J. Hyg.*, **45**, 480 (1947).

## Transpiration into a Saturated Atmosphere

PROF. D. THODAY'S suggestion[1] (apropos of the work of Dixon and Barlee[2]) of a possible mechanism of transpiration into a saturated atmosphere, based on the enhanced vapour pressure of convex water surfaces, is an attractive one, especially as it is a logical corollary of the older idea of the significance, in the water economy of a wilting leaf, of the subnormal vapour pressure of concave evaporating surfaces[3]. There are, however, certain difficulties in its application.

The increase in vapour pressure of a convex water surface becomes appreciable only when the radius of curvature is very small, and the corresponding exudation pressure necessary to maintain such a surface will then be very high. For example, the development of a vapour pressure even 1 per cent above normal would require an exudation pressure from the mesophyll cells of about 13 atmospheres: a 10 per cent increase would require about 130 atmospheres. Thus, although the formation of such highly convex surfaces may maintain evaporation in saturated air, it must place a heavy load on the necessary initial secretion process. Furthermore, convex menisci of the form visualized will be unstable at their minimum radius of curvature (that is, when they would be most effective as evaporating surfaces) and may readily give rise to much larger droplets. For though a progressively increasing exudation pressure is necessary initially to expand a plane water surface into a convex one, when the latter becomes hemispherical, further expansion, being accompanied by an increasing radius of curvature (and hence requiring a lower equilibrium internal pressure), takes place spontaneously. This effect may be simply demonstrated on a comparatively large scale by the slow extrusion of a droplet, under a small 'head' of water, at the end of a thick-walled capillary tube. The tube must be free from grease internally and the end should be ground flat and waxed to simulate the assumed conditions of the capillaries of the walls of the mesophyll cells.

If convex menisci are formed on the walls of mesophyll cells, some injection of the intercellular spaces may therefore be expected to follow. This is in accord with Lewis's observation[4] of the formation of a *layer* of water on the surfaces of mesophyll cells. It is perhaps significant also that Dixon and Barlee observed some injection of the intercellular spaces of the leaf in one of their experiments.

Although, as Prof. Thoday states, they have disposed of certain criticisms of earlier work and have demonstrated a comparatively long-continued uptake of water by cut shoots in saturated air or in aerated water, yet the ultimate fate of the water absorbed is still an open question—experimental proof of its escape from the leaves under these conditions would clearly be no easy matter. If, as Lewis suggests, transpiration involves an active secretion of liquid water followed by evaporation, then it seems possible that the results of the experiments of Dixon and Barlee may be due to the persistence of this secretion in spite of the suppression of evaporation. If this is so, then the absorbed water must be held in the intercellular space system, and it would be interesting to know whether a cut shoot can be maintained under the conditions of these experiments sufficiently long for this accumulation of water to be definitely proved or disproved. An appreciable volume of water might be held in this way before obvious injection of the spaces supervened, and it would seem that this possibility cannot be ignored.

K. Wilson

Department of Botany,
Birkbeck College,
London, E.C.4.

[1] *Nature*, **164**, 541 (1949).
[2] *Sci. Proc. Roy. Dublin Soc.*, **22**, 211 (1940).
[3] Sresnevski, see Maximov, "The Plant in Relation to Water", 159 (1929).
[4] Discussion of the Faraday Soc., No. 3, 159 (1948).

---

The instability of a convex meniscus at its point of maximum curvature to which Dr. Wilson directs attention is interesting. It would presumably result in a flooding of the air-spaces once the limit were passed.

Lewis's observations, however, indicate that normally no layer of water is formed over the unwettable surface of mesophyll cells, even when water vapour from them condenses on a cover-glass immediately above. It is difficult, therefore, to accept the suggestion that exudation of water into the intercellular spaces might account for the water taken up by the shoots in Dixon and Barlee's experiments.

The smallness of the vapour-tension differences does not necessarily rule them out as a significant factor. The rates of water intake observed are low. Continued for many hours, these rates, low as they are, add up to an appreciable volume. In referring to the precautions taken to secure complete saturation, Dixon and Barlee (pp. 14–15) state that they have observed the process continuing in some cases as long as four days after the preliminary period of 20 hr. in supersaturated air. As the bore of their potometer capillary was 1 mm., a rate of 1 mm. per minute would mean nearly 5 c.c. in four days. This seems rather much to stow away unobserved in the intercellular spaces. A rough estimate of the volume of leaf tissue concerned can be obtained from Dixon and Barlee's data for a shoot of *Abutilon*, with nine leaves, of average area 100 sq. cm. Assuming a thickness of 0·1 mm., the total volume of the mesophyll would be about 9 c.c.; or if 0·2 mm. thick, 18 c.c.

Moreover, Dixon and Barlee record that, notwithstanding the thorough pretreatment of a shoot to ensure saturation, eosin applied to the cut end reached in many cases the finest ramifications of the veins, so that "the whole tracheal system of the submerged branch has been emptied by subaqueous transpiration".

It seems unlikely that water taken up in such amounts could all be retained.

D. Thoday

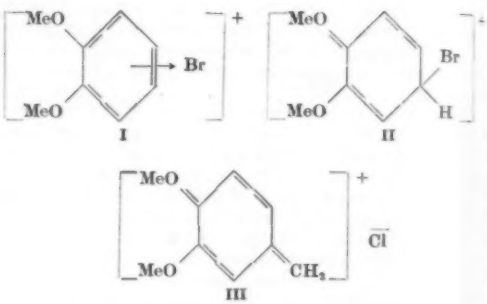
Bangor.
Nov. 9.

---

## Veratrole and π-Complexes

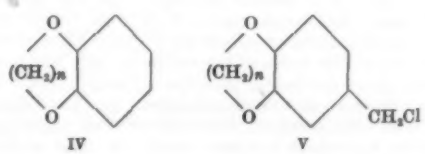
The bromination of veratrole proceeds more readily than that of anisole, and this comparison has led Dewar[1] to propose that the former reaction employs the π-complex I rather than a complex of type II.

Dewar's argument is based on the assumption that formation of II is adversely affected by the methoxyl group in the *meta* position to the centre of attack, whereas both methoxyl groups facilitate the formation of I.




For many years chemists have attempted to relate rate of aromatic substitution to side-chain reactivity, and the considerable success they have obtained suggests that the criteria of aromatic substitution are associated with the individual carbon atoms of the benzene ring rather than with the π-orbitals of the ring as a whole. In the present instance, it is instructive to relate the rates of bromination of veratrole and anisole respectively to the rates of unimolecular alcoholysis of veratryl and anisyl chloride respectively. Ionization is the rate-determining step in the alcoholysis of these chlorides, and the rate of formation of the cation III provides a measure of the ease of formation of the complex II.

The alcoholysis of veratryl chloride is as many times faster than that of anisyl chloride as the bromination of veratrole is faster than that of anisole[†]. The rates of alcoholysis demonstrate that both methoxyl groups make a greater contribution to the resonance energy of the veratryl cation than to that of veratryl chloride, and one must conclude that both methoxyl groups in veratrole facilitate, simultaneously but not equally, the formation of complexes of type II. Thus, although evidence of the formation of π-complexes is accumulating, the rate of bromination of veratrole affords no evidence of the formation of the π-complex I.



The data discussed above form part of an extensive programme designed to relate chemical and physical properties to intramolecular configuration and, as a sequel to the above discussion, we might add that the substances IV ($n$ = 1, 2 and 3 respectively) are brominated much *less* readily than anisole, and that the chloro compounds V ($n$ = 1, 2 and 3 respectively) are much *less* reactive than anisyl chloride. The significance of these surprising results will be discussed elsewhere.

G. Baddeley
Neville H. P. Smith

Department of Chemistry,
College of Technology,
Manchester 1.
June 24.

[1] Dewar, Farad. Soc. Discussion, **2**, 53 (1947).
[2] Unpublished work.

## A New Intermetallic Phase in Alloy Steels

An X-ray examination of a number of residues separated electrolytically from steels containing chromium, nickel and molybdenum has revealed the presence of a new constituent, which we designate 'χ'. The residues contained varying amounts of the σ-phase, the carbide $(Cr, Fe, Mo)_{23}C_6$, and χ itself. This new constituent does not appear to be a simple high- or low-temperature alternative form of the σ-phase itself, and its full significance is not yet established.

Chemical analysis of a residue which contained a large amount of the χ-constituent showed a closer similarity in chemical composition between it and the σ-phase than might have been expected, the most marked differences being in the nickel, molybdenum and silicon contents.

X-ray powder patterns with cobalt $K\alpha$ radiation, using a β-screen between the specimen and photograph, of σ- and χ-phases

| σ-phase† | | χ-phase (cubic $a_0$ = 8·860 kX.) | | | |
|---|---|---|---|---|---|
| Intensity | Interplanar spacing | Intensity | Interplanar spacing | $N$ | $hkl$ |
| | kX. | | kX. | | |
| vvw | 2·370 | *vw | 2·368 | 14 | 321 |
| vw | 2·275 | vvw | 2·215 | 16 | 400 |
| s | 2·128 | s | 2·088 | 18 | 330, 411 |
| wm | 2·067 | *w | 1·981 | 20 | 420 |
| w | 2·019 | *w+ | 1·889 | 22 | 332 |
| wm | 1·969 | *w− | 1·809 | 24 | 422 |
| s | 1·928 | w | 1·738 | 26 | 510, 431 |
| m | 1·883 | w | 1·437 | 38 | 611, 532 |
| vw | 1·839 | w | 1·279 | 48 | 444 |
| vw | 1·603 | w− | 1·253 | 50 | 710, 550, 543 |
| w | 1·254 | ms | 1·206 | 54 | 721, 633, 552 |
| w | 1·236 | w+ | 1·125 | 62 | 732, 651 |
| w | 1·219 | *vw | 1·091 | 66 | 811, 741, 554 |
| w | 1·205 | *vw | 1·074 | 68 | 820, 644 |
| vw | 1·196 | m | 1·044 | 72 | 822, 660 |
| vw | 1·164 | w | 1·030 | 74 | 831, 750, 743 |
| vw | 1·136 | w− | 1·003 | 78 | 752 |
| wm | 1·0647 | (*vvw | 0·9905 | 80 | 840) |
| wm | 1·0355 | vw | 0·9784 | 82 | 910, 833 |
| vw | 0·9976 | vw | 0·9444 | 88 | 664 |
| vw | 0·9880 | m | 0·9339 | 90 | 930, 851, 754 |
| wm | 0·9808 | | | | |
| vw | 0·9429 | | | | |

* These χ-lines were frequently overlapped by lines of other constituents.

† The σ-phase from which these interplanar spacings are derived was the main constituent in an alloy containing 46·9 per cent Fe, 4·9 per cent Cr, 8·2 per cent Ni. Slightly lower spacings apply to a σ-phase of composition near 3 per cent Ni, 40 per cent Cr and 57 per cent Fe. Higher spacings are obtained from σ-containing molybdenum in solid solution.

Debye–Scherrer powder photographs show that the χ-phase has a structure very similar to that of α-manganese. It is based on a body-centred cubic structure of spacing $a_0$ = 8·860 kX. Some samples have a slightly higher spacing indicating a varying solid solution content. Bradley and Goldschmidt[1] have suggested that there is a slight resemblance between the σ-phase itself and α-manganese, a point which has been discussed elsewhere[2]. The σ-phase has, however, a sufficiently different crystal structure, is not cubic and can therefore be definitely distinguished from the χ-phase. The χ-phase has so far only been discovered in steels containing molybdenum and may thus be associated with the presence of that element (and possibly also tungsten). The powder patterns of the two phases are listed in the accompanying table. (The structure and unit cell of the σ-phase are not known.)

K. W. Andrews

The United Steel Companies, Ltd.,
Research and Development Department,
Stockbridge, Nr. Sheffield.
July 20.

[1] Bradley, A. J., and Goldschmidt, H. J., *J. Iron and Steel Inst.*, **144**, 273 (1941, ii).
[2] Andrews, K. W., *Research*, **1**, (10), 478 (1948).

## Heating Metal Specimens in Corrosion Tests

During recent work in these Laboratories on the resistance of metals to boiling organic liquids, an investigation of various methods of heating has been carried out. We have found that much higher solution-rates are obtained when the heat of vaporization is supplied through the surface of the test piece than when the liquids are heated in the usual way by gas flames applied to the glass apparatus.

Through the courtesy of Messrs. Rediffusion, Ltd., we have been able to show that a convenient method of providing heat through the test piece is by induction heating. Reproduction of results is better than by gas heating, providing the heat flux is kept sufficiently high to ensure boiling over the whole area of the test piece.

Typical solution-rates, in milligrams per square decimetre per day, for mild steel are shown in the accompanying table, where the corrosive liquid is dehydrated crude tar acid.

| Watts to anode of induction heater | Solution-rate (mgm./sq.dcm./day) | Reflux-rate (ml. per min.) |
|---|---|---|
| 111 | 1,720 | Just boiling |
| 273 | 8,100 | 2·9 |
| 358 | 10,000 | 3·8 |
| 572 | 14,000 | 7·5 |
| (Liquid heated by gas) | 3,500 | 5 |

This method of corrosion testing gives promise of becoming a useful tool for assessing probabilities of corrosion in practice, especially where heat transfer through metal surfaces to corrosive liquids is involved.

R. F. Thirsk
G. H. Botham
G. A. Dummett

A.P.V. Company, Ltd., Laboratories,
Wandsworth Park,
London, S.W.18.
July 21.

# FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

## Monday, December 12

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Dr. J. Crighton Bramwell: "The Changing Face of Medicine" (Ramsden Memorial Lecture).*

INSTITUTION OF THE RUBBER INDUSTRY, MANCHESTER SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.15 p.m.—Mr. C. E. Webb: "Sulphur Chloride Reactions in relation to the Rubber Industry".

INSTITUTION OF THE RUBBER INDUSTRY, LIVERPOOL SECTION (at Common Hall, Hackins Hey, Liverpool), at 7 p.m.—Dr. F. H. Cotton: "The History of Rubber".

CHEMICAL SOCIETY, ABERDEEN SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, in the Chemistry Department, Marischal College, Aberdeen), at 7.30 p.m.—Prof. H. J. Emeléus, F.R.S.: "Some Recent Advances in the Chemistry of Fluorine Compounds".

## Tuesday, December 13

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. M. Coulson: "The Flow of Fluids through Granular Beds—Effect of Particle Shape and Voids in Streamline Flow".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. A. G. Evans: "Polymerization by Friedel-Crafts Catalysts". (Members of the Faraday Society are invited.)

INSTITUTION OF WORKS MANAGERS, LEICESTER BRANCH (at the College of Technology, The Newarke, Leicester), at 7 p.m.—Mr. R. F. Wilson: "Colour and Lighting in Industry with special reference to Factories and Offices".

INSTITUTION OF THE RUBBER INDUSTRY (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Mr. S. C. Stokes: "Latex Moulding by Plaster Casting"; Dr. C. F. Flint: "Latex Moulding by the Slush Process".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at Philips Electrical, Ltd., New Road, Mitcham Junction), at 7.15 p.m.—Dr. H. A. Klasens: "Chemistry of Bioluminescence and its Importance in Animal Behaviour".

INSTITUTION OF THE RUBBER INDUSTRY, SCOTTISH SECTION (at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent, Glasgow), at 7.30 p.m.—Mr. H. C. Harrison: "Rubber in the Manufacture of Cables".

SOCIETY OF INSTRUMENT TECHNOLOGY, NORTH-WEST SECTION (in the Reynolds Hall, College of Technology, Manchester), at 7.30 p.m.—Dr. G. Jessop: "Gas Analysis by Katharometer".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Scientific Approach to Human Problems in Industry" (Speakers: Sir George Schuster, K.C.M.G., Mr. W. B. D. Brown and Dr. R. S. Tredgold).

## Wednesday, December 14

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Dr. Ernest Marsden, F.R.S.: Fourth Rutherford Memorial Lecture.

INSTITUTION OF ELECTRICAL ENGINEERS, SUPPLY SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. J. S. Forrest: "The Performance of the British Grid System in Thunderstorms".

ROYAL MICROSCOPICAL SOCIETY (in the Hastings Hall, B.M.A. House, Tavistock Square, London, W.C.1), at 5.30 p.m.—Mr. E. Wilfred Taylor: "The Phase-Contrast Microscope"; Dr. A. F. W. Hughes: "Mitosis in the Cells of the Mouse in Tissue Culture".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (at the Portico Library, Mosley Street, Manchester), at 5.30 p.m.—Mr. A. J. P. Taylor: "Communism in the Second World War".

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. W. J. Mulders: "Oil in the Netherlands and Emsland".*

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Discussion on "The Nation's Manufactured Foods, 3, Soups as Foods" (Speakers: Mr. Henry Sarson, Mr. J. G. Hunsley and Miss B. R. Stanton).

IRISH CHEMICAL ASSOCIATION (in the Department of Chemistry, Trinity College, Dublin), at 7.45 p.m.—Mr. T. F. O'Reilly: "Some Aspects of Water Chlorination".

## Thursday, December 15

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. H. G. Maule: "Studies in the Laundry Industry; a Re-examination".

CHEMICAL SOCIETY, LIVERPOOL SECTION (in the Lecture Theatre, Chemistry Department, The University, Liverpool), at 4.30 p.m.—Dr. W. Charles Evans: "The Biological Oxidation of certain Aromatic Compounds with Special Reference to the Bacterial Cleavage of the Benzene Ring".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Robert Hooke" (The Wilkins Lecture).

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. G. Hill: "Management in Industry".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. L. B. Cooper: "Operator Theory and Quantum Mechanics".

PHYSICAL SOCIETY, ACOUSTICS GROUP (in the Small Physics Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5 p.m.—Discussion on "Dead Rooms" (to be opened by Mr. G. P. Horton).

ELECTRICAL ASSOCIATION FOR WOMEN (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Miss Elizabeth Gwillim: "Electrification and Reconstruction in Holland" (Fourth Caroline Haslett Trust Lecture).

INSTITUTE OF NAVIGATION (joint meeting with the ROYAL AERONAUTICAL SOCIETY, at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Dr. D. E. Adams and Dr. A. S. Uttley: "Navigational Systems and Instrument Aids".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. A. L. Whitwell: "Electronics in Aircraft Design".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.15 p.m.—Scientific Papers.

## Thursday, December 15—Friday, December 16

BRITISH INSTITUTE OF RADIOLOGY (joint meetings with the ROYAL SOCIETY OF MEDICINE, at 32 Welbeck Street, London, W.1, on Thursday, and at 1 Wimpole Street, London, W.1, on Friday), at 8.15 p.m. each day—"Physical Properties and Performance of Fluorescent Materials and Amplification of the Intensity of the Fluorescent Image".

## Friday, December 16

BIOCHEMICAL SOCIETY (in the Department of Biochemistry and Chemistry, Guy's Hospital Medical School, London, S.E.1), at 2 p.m.—Scientific Papers.

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Lieut.-Comdr. P. G. Satow: "Radar Charts".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. R. J. Sarjant: "Furnace Design and Practice".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL METHODS STUDY GROUP (at the Albert Hall, Peter Street, Manchester), at 5.30 p.m.—Mr. C. F. Carter: "Problems of Measuring the Real National Product".

INSTITUTION OF ELECTRONICS, NORTH-WESTERN BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Mr F. F. Heyman: "The Betatron".

ROYAL METEOROLOGICAL SOCIETY, SCOTTISH CENTRE (at the University, Edinburgh), at 7.30 p.m.—Mr. F. P. Henderson: "Greenland Expeditions".

## Saturday, December 17

INSTITUTE OF PHYSICS, SOUTH WALES BRANCH (at University College, Swansea), at 2 p.m.—Dr. F. Hoyle: "The Expanding Universe".

---

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ELECTRICAL ENGINEERING in the Ministry of Supply School of Electronics in the South Midlands—The Establishment Officer, Ministry of Supply, Est. 3(B)1, The Adelphi, Strand, London, W.C.2 (December 17).

ASSISTANT IN THE PLANT PATHOLOGY SECTION in research on fungus and bacterial diseases of fruit and hops—The Secretary, East Malling Research Station, Maidstone, Kent (December 17).

ASSISTANT CHEMISTS at Ironbridge and Walsall Generating Stations—The Divisional Establishments Officer, British Electricity Authority, Midlands Division, 53 Wake Green Road, Moseley, Birmingham (December 17).

ASSISTANT ANALYTICAL CHEMIST—The County Clerk, County Buildings, Dumfries (December 17).

DEPUTY COAL SURVEY OFFICER at the Coal Survey Laboratory, Sheffield—The National Coal Board, Establishments (Gener l) Branch, Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/167 (December 20).

SENIOR SCIENTIFIC OFFICER (Engineer) to carry out research in structural engineering particularly in connexion with steel or reinforced concrete framework, a SENIOR SCIENTIFIC OFFICER (Physicist) with a particular interest in problems in the field of heat transmission in solids, liquids or gases, an EXPERIMENTAL OFFICER (Physical Chemist) preferably with some experience in the manufacture of building materials, in particular floor surfacing materials, an EXPERIMENTAL OFFICER (Chemist) preferably with some degree of specialization in physical chemistry and with experience in the field of tars and bitumens, and an EXPERIMENTAL OFFICER (Chemist) to assist in the preparation of technical information about the use of building materials in the Colonies, etc., at the Building Research Station of the Department of Scientific and Industrial Research—The Secretary, Civil Service Commission, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2874 (December 21).

PRINCIPAL SCIENTIFIC OFFICER (Physicist) with a First or Second Class honours degree, at the Joint Fire Research Organization of the Department of Scientific and Industrial Research, Boreham Wood, Herts, to conduct and supervise fundamental research into the problems of heat transmission which influence the initiation, development and the effects of fire—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2876 (December 22).